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## BRAIN-FORCING IN CHILDHOOD.*

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NOT very long ago a lady of this city brought her little daughter, twelve years of age, to see me professionally. The child was on her way to school, and had with her a large satchel full of books. She was pale, tall, and thin. The muscles of her face twitched convulsively, and she could not keep her hands and feet still. She was suffering from chorea, or St. Vitus's dance, and, in addition, had almost constant headache and other symptoms of nervous derangement. In the course of my examination I asked her to empty her satchel of the books it contained, and which, as she informed me, she had been studying that morning and the night before. This is the list:

1. An English grammar. 2. A scholar's companion. 3. An arithmetic. 4. A geography. 5. A history of the United States. 6. An elementary guide to astronomy. 7. A temperance physiology and hygiene (whatever that may be). 8. A method of learning French. 9. A French reading-book.

Nine in all—nine different subjects of knowledge which that poor child was required to study between the hours of three in the afternoon of one day and nine in the morning of the following day! Allowing one hour for dinner, half an hour for breakfast, an hour for undressing at night and dressing in the morning, an hour for going home and returning to school, and eight hours for sleep (and less than this will not suffice for a growing boy or girl—it had better be nine or ten), and we have six hours and a half left in which to study nine different branches of learning! Now, suppose either one of you ladies and gentlemen should retire to some quiet nook, and, with your well-developed and trained brains and experienced minds, should try to study nine unfamiliar subjects of knowledge in six hours and a half,

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would you think it strange if at the end of that time you should somewhat mix matters, and imagine that Hong-Kong is the name of a lunar volcano, that the Continental Congress is one of the parts of speech, and that the ductus communis choledechus is situated on Passamaquoddy Bay? *She* showed no such confusion of ideas. She had studied her lessons well, but she had done so at the expense of her brain-substance. In a little while, and English grammar, geographies, and temperance physiologies, would have been like the "subsequent proceedings" in Bill Nye's poem; they would have "interested her no more." I say that she had learned her lessons at the expense of her brain-substance. This is no flower of speech, but a sober fact. A very simple examination enabled me to satisfy myself that she was living on her brain-capital instead of her brain-income. Her expenditures were greater than her receipts, and brain-bankruptcy was staring her in the face.

An instance like this, in which disease is directly the result of excessive use of the brain, is only one of the many that are constantly coming under the observation of physicians. It is not at all likely that any remarks of mine, or the lessons that experience is daily giving to parents, will for a long time yet do much in the way of making such cases fewer. We are living under the reign of the schoolmaster. The impulse to have children acquire learning that can never be made available for any purpose of life is so powerful that it may almost be regarded as morbid. And this is especially the case relative to girls, who are made to spend years in getting a smattering knowledge of subjects which, if they knew them well, would not enhance their loveliness or render them any happier; but which, as it is, befog their minds with a multiplicity of ideas no one of which they clearly comprehend. Do not misunderstand me. I am not underrating the advantages of learning. If a person wishes to study the differential calculus, not with a view of benefiting his fellow-man, but for the object of conducing to his own happiness, let him do so. He will be wiser and better, and, whether he intends it or not, his fellow-man will be benefited. He has a right to judge for himself, and to seek his own happiness in the way that seems best to him. But for children to be reduced to one common level, as they are in our schools almost without exception, and to have studies crowded upon them in advance of their brain-development, are crimes against Nature, which Nature in her blind way expiates by punishing the wrong person, but which those who know the right should promptly expose.

The brain of a child is larger in proportion to its body than is that of the adult. A fact which is somewhat astonishing to those not aware of it is, that the head of a boy or girl does not grow in size after the seventh year; so that the hat that is worn at that age can be worn just as well at thirty. In the mean time the rest of the body has more than doubled in magnitude. Not only is the brain larger, but it is

more excitable and more impressionable in the child than in the adult. At the same time the structure is immature. What it possesses in size it lacks in organization; consequently it is not at its maximum for severe and long-continued exertion, and when subjected to a strain of this kind it is certain to suffer. We have, all of us, seen children become mentally fatigued from very slight causes, even when they have been at the same time greatly interested. How much more, therefore, must their brains be tired when they have been forced to concentrate their attention upon subjects, the importance of which they do not appreciate!

The disadvantages to the child of overtasking its muscular system are well understood, and wise laws have been enacted by most civilized people protecting children from the greed of those who would, if left to their own devices, work them to excess. But there are no laws for the protection of their brains from the attacks of ignorant parents and guardians, the insidious warfare of the compilers of school-books who write treatises on physiology in rhyme for infants, and the ever-ready schoolmaster, who, with the child, a victim of a pernicious system, must carry out the behests of those set over him.

Every person who has tried both knows that an hour of intense mental exertion fatigues the whole system more than does a corresponding amount of the most severe physical work. The reason for this is very evident. The brain not only furnishes the force for thought and the other elements of the mind, but it keeps in action all the other organs of the body. If, therefore, the mind takes more than its share of this force, the heart, the stomach, the lungs, the muscles, suffer, and the feeling of weariness is experienced.

It must be borne in mind, also, that the brains of children are continually engaged in acquiring a knowledge of the objects and circumstances by which they are surrounded. An adult, for instance, goes into a room, and the things it contains scarcely attract his attention. He has already learned them. But with the child it is very different. He looks at every object with inquiring eyes; if possible he takes them into his hands so that he can get fuller ideas of them, and asks a hundred questions in regard to their qualities, uses, etc. From the very earliest period after birth the infant is in pursuit of knowledge. His open eyes stare with astonishment at the things within their range, and in a little while his other senses are brought into requisition to assist in adding to his acquirements. An infant two months old will stretch out his hands toward objects held near him, and will incline his whole body with arms extended toward those that he has already learned are too far off for him to grasp. Perhaps, as Plato says, all these manifestations are due to the wonder with which the child's mind is full, but they lead to knowledge whatever may be the exciting cause, and they result directly from the action of the brain.

Undoubtedly the first faculties of the child's mind to be brought

into action are the perceptions or senses; and for their exercise, certain organs, as the eye, the ear, the nose, the tongue, the skin, are provided. Through these organs the education of the infant takes place, beginning at birth, and even, as there is good evidence for believing, before birth. Were it not for these instruments, as they may be called, no single point of knowledge could be acquired, no idea formed. The brain, no matter how perfect its organization in other respects, might as well, so far as thought, feeling, and all relations with the external world are concerned, be a block of wood.

The intellect of the infant is immature, for the reason that the part of the brain which is concerned in the process of elaborating the higher qualities of the mind, is in a far more imperfect state of development than is that part which has direct relations with the organs of the special senses. The perceptions and the ideas that are elaborated from them give all the exercise to the inchoate brain that it requires for its full development. Through the perceptions the systematic education of the child should be almost exclusively conducted during the first ten or twelve years of life, and there should be no set lessons to worry his power of attention, to spur his understanding, or to tax his memory. He should be taught how to acquire knowledge by the use of his senses, and there are facts enough surrounding him on all sides to keep him as much engaged as is proper. His own reflections, started into activity, as they will be by his perceptions and by the questions he will ask, will do the rest. He will learn to read almost imperceptibly, of his own accord, with scarcely a word of instruction. If he does not begin to look at books till he is ten years old, he will, by the time a year has elapsed, read better than the child that has begun to learn his letters at three or four. He starts in the race with an unwearied and a better developed brain, and in the long run through life will win more prizes than his precocious competitor.

It is astonishing to find how greatly the perceptions of children are neglected by those who have them in charge. I have frequently been struck with the fact that even pupils who are considered to be well advanced do not know how to use, with even moderate ability, their sense-organs. I met not long ago with a boy of ten years who had mastered, to the satisfaction of his admiring parents, several branches of knowledge; and yet, when shown a picture in a child's book, told to look at it closely for a minute, and then to tell what he had seen, could name only a man, a horse, and a tree. His little sister, seven years old, who did not know how to read, and who was regarded by the father and mother as being somewhat stupid, saw, under like circumstances, a man, a horse, a tree, two little birds on the ground, a cat crawling through the bushes and about to spring on them, a house, a woman standing in the door, and a well at the side of the house. I had the satisfaction of telling the parents that at sixteen she would know a good deal more than would the boy at that age, provided she

had an equal chance. Here is the opportunity for those who have charge of children during the first ten or twelve years of their lives. All Nature is before them: the woods, the fields, the sea, the heavens, animals of all kinds, men and women, the habitations of man, factories and the various objects made in them, and a thousand other things, afford the means for educating the child without a single book being brought into use. Even very young children can be taught to employ their eyes to some purpose by having attractive pictures submitted to them for observation. Such exercises would interest the mind, and at the same time develop it. The picture-books made nowadays are generally very admirable; but there might be pictures specially designed for the purpose of teaching and not merely for amusement.

One of the greatest mistakes made in our present system of educating children is, that they are given too many subjects to study at once. The power of dissociation—that is, of keeping one subject entirely clear of another subject—is not great in the minds of children. They therefore have a mass of confused ideas when they have got through with their daily tasks, which it is always difficult, and sometimes impossible, for them to separate one from the other. It is true that some children are, from the beginning, able to concentrate the attention first on one subject and then on another; but these are quite exceptional instances, and the brain is very likely to be strained in the effort. It is as though a person should spend six hours in looking alternately through a telescope and a microscope, giving a few minutes to each. It would certainly be found at the end of that time that the sight had been injured for the time being, at least, and if the practice should be continued there can be no doubt that permanent impairment of vision would be the result.

The effort to form and maintain clear and forcible ideas of several subjects at once is a difficult matter, even for adults. It has been found by experience that it is advantageous to reduce the number of branches of medical science which students are required to study simultaneously. Several of the better class of medical colleges in this country a few years ago cut down the list of from eight or ten to less than half the number, and extended the period of study from two sessions of four months each to three of from six to eight months. I speak from personal experience when I say that I am aware of the most lamentable results of the "cramming" process in medical students. I have been a teacher in medical schools for nearly twenty-five years. In the course of my examinations it has often happened that I have put a question in one branch of medicine to a candidate for graduation and have received an answer in an entirely different branch. How much better it would be for the future man or woman if the boy or girl, instead of being required to learn a dozen different subjects at once, as was the poor little victim of St. Vitus's dance to whom I referred in the beginning of my remarks, should have the number reduced

to two, or at most three! Geography, for instance, might easily be sufficiently learned in three months if it were taught exclusively, and so of many other subjects. As for grammar, it should be banished from all schools, except perhaps from the senior year of a university course. No child ever learned to speak good English from studying grammar. It has driven many a poor little wretch into headaches and other nervous troubles. It is the most ingenious device for forcing an immature brain into early decrepitude that the cunning of man has yet devised. The only reason why it does not do more harm is, that not one in ten of the pupils that come out of our schools know anything about it.

So far as my experience goes (and my profession has brought me many opportunities for observation), there is too much cramming in all our schools, and too much learning by rote, without there being an understanding of the subjects studied. It appears to be the main object of some teachers to develop the memory at the expense of the other mental faculties. Now the memory is one of the lowest faculties of the mind. In fact, it is not a faculty, but simply the result of the registration of impressions. It is a property of certain parts of the brain-substance, and it often exists in its highest form in persons of low intelligence, in whom it is exerted automatically, as it were, and without reason. If the perceptions and the power of mental concentration be cultivated, the memory will take care of itself.

It is generally the case that those persons who possess good memories are deficient in the capacity for giving attention. Facts and circumstances make little impression upon us all as we grow older. Hence we find that the events which occurred in childhood, and which were registered then, are easily remembered, while those that happened only a few weeks ago, not having been sufficiently noticed at the time, made little impression on the registering apparatus of the brain, and are partly or wholly forgotten.

Persons with good memories are, as a rule, indifferent students; they trust to memory rather than to understanding, and hence rarely have clear and full ideas of the subjects studied. Of course there are persons with strong memories and great intelligence and powers of application, but they do not require schools. They are competent to take care of themselves, and they do. The text-books used in schools generally take too much for granted on the part of the student. Bald statements are made without sufficient explanation; the pupil learns them by heart, and is supposed to know all about them because he can recite them without missing a word. I recollect how it was with myself in the matter of geometry. I took the first premium at school for recitations in that branch of science. I used to go up to the blackboard, draw all my lines correctly, and then, without hesitating at a word, glibly make the required demonstration; and yet of the real nature of geometry I had no idea. I did not know the use of it, nor

did I acquire the knowledge till, some years subsequently, I took up the matter for myself. How often it is the case in our schools that memory passes for knowledge, leading to the belief that the possessor has mastered a subject, when in fact scarcely an inkling of it is obtained! They make admirable recitations, but so does a parrot.

It may be said that, although at the time a subject is not understood by the child, the memorizing of the words in which the details of it are expressed helps him in after-life to comprehend it. This I am sure is erroneous. The exact language used is of no consequence; time is wasted in acquiring it—time that might be much more profitably employed in obtaining ideas. And very often it happens, from the inability of the compilers of school-books to write good English, that the words used are not such as best express the idea sought to be conveyed, and indeed are sometimes altogether wrong. Thus, for instance, in a recently published history of the United States "pyrites" is defined as "a yellowish mineral of no value, but from its likeness to gold sometimes mistaken for it." This is almost as bad as the definition of crab given by the French academicians as "a small red fish, which goes backward." As Cuvier remarked, this is correct, except in three respects—a crab is not red, it is not a fish, and it does not go backward. In the same book "knighthood" is defined as "a rank in nobility." Such errors as these, as I have ascertained by inquiring, are not corrected by the teachers.

The "cramming" process not only results in injuring the brain, but it tends to give only superficial ideas of many subjects instead of a thorough knowledge of a few. It is greatly to the detriment of society that it should contain, as it does, a large proportion of persons who have imbibed a superficial acquaintance with branches of learning that, in the ordinary courses of their lives, they are not likely to make use of. As remarked by General Fry, in his admirable address, a few days ago, before the Military Service Institution, they are often tempted to employ their acquirements in the perpetration of crimes requiring some, though perhaps very slight, scientific knowledge, and again in concealing the evidence of their unlawful acts. It is very certain that such crimes were never so common as at the present day, when almost every person has at least a smattering knowledge of physics, chemistry, and toxicology.

The men and women who have made the most of themselves are those who have begun to study hard after they have reached adult life, when the brain and nervous system have more nearly arrived at their fully developed stage. It is true that the world has seen many geniuses, who have taken their education into their own hands, regardless of schools and teachers; but mankind is not made up of geniuses. I doubt if there be a single one in any school in the city of New York, and therefore in a paper like this it is not necessary to take them into consideration.

These people who make their own way, unaided by wealth or influence, have never studied a dozen or more subjects at the village school, where at most they learned the "three R's"—reading, writing, and arithmetic—and where their physical forces were not deteriorated by want of bodily exercise. What they learned from the country schoolmaster they learned well, not because of any original superiority of their brains over the brains of the children of the present day, but because they did not go to school till they were well-grown children, and, further, for the reason that their minds were not tortured with a multiplicity of subjects to be learned, or goaded by the system of competition which prevails in almost all schools of the present day. Then, when they had arrived at that period of life at which their predilections were formed, they entered with ardor upon studies that they selected for themselves; for they knew exactly what they wanted, and governed themselves accordingly. They frequented reading-rooms and libraries, at such times as they could take from the labor necessary for their support, and they devoted their nights to the study of matters that it was necessary for them to understand. One hour of this kind of mental work, with a brain near its full development, and with the attention roused to its utmost power of exertion by the sense of necessity, the spur of ambition, the longing for success, is worth more than three times the amount with brains needing all their force for natural growth, and which are confused and painful from the alternate blandishments and lashings to which they have been subjected.

If a law were passed prohibiting the public schools teaching children under ten years of age from books, and restricting the education given therein to the elementary branches of English, I am sure that, as the ages of the pupils increased, healthy differentiations would take place. The principle of natural selection would come into action, and the result would be beneficial both to the individual and to the State. Something like this is now being attempted in a few of our colleges, and it appears to work well. It is not often the case that pupils will, of their own accord, cram themselves beyond their capacity, though cases now and then occur, through the operation of the factors of competition and an inordinately stimulated ambition, in which there is such a perversion of the natural tendencies that children eagerly overwork themselves at school. We should no more trust children with a superfluity of studies than we should place them at a table filled with toothsome edibles and tell them to eat as much as they wanted. In the one case there would be mental and in the other bodily indigestion. Montaigne speaks with no uncertain voice in regard to this matter.

"Too much learning," he says, "stifles the soul just as plants are stifled with too much moisture, and lamps by too much oil; for pedants plunder knowledge from books and carry it on the tip of their lips, just as birds carry seeds wherewith to feed their young. The care and expense that we received from our parents in our education

go for nothing but to furnish our heads with knowledge, but give us nothing of judgment or virtue. We labor only to stuff the memory, but leave the conscience and the understanding empty and unfurnished."

"Mere bookish learning," he says again, "is both troublesome and ungraceful; and, though it may serve for some kind of ornament, there is yet no foundation for any superstructure to be built upon it."

Students of mature life study the things themselves, and not the descriptions of them. How much better it would be if "object-lessons" were more common in our schools! What idea of "network," for instance, could a child possibly obtain from Dr. Johnson's definition of it, "a reticulated structure, with interstices between the intersections"? Would he not know more about a net after having seen one than he would after having learned by rote such a definition? And would not, in fact, the words used by Dr. Johnson tend to unsettle all the knowledge of a net that observation had given him?

As one mode by which a reform in our systems of educating the young can be brought about, let there be more schools for children of a larger growth. I am satisfied, from observation, that the public night-schools of this city do more good, according to their opportunities, than do those that, through the day, from nine to three o'clock are crowded with young children, tiring their poor little brains over subjects that do not interest them, for they do not appreciate their value. A child ought to see some tangible result of his efforts to acquire knowledge, and this he can only do when he is taught facts that he understands and recognizes to be facts. In this kind of instruction the mental strain is reduced to a minimum, while the mental development is carried on in accordance with Nature's laws. At the first sign of fatigue the instruction should cease. As our schools are at present conducted, all the pupils are made to conform to one uniform standard of cast-iron rigidity. Weariness counts for nothing with the feeble, so long as the robust are not tired. The exhausted child can not, like the exhausted adult, stop of his own volition. He must go on. The jaded nervous system cries out in vain, his face may look as haggard as it can, yawn follows yawn, his head may droop, his eyes may close in the drowsiness of his languor; but the goad is applied, and he must rouse himself, for another lesson is to be recited. Is it strange that headache, and nervous prostration, and insomnia, and St. Vitus's dance, and epilepsy, and utter extinction of mind should frequently result from this forcing process? Is it not much better for the child that he should occasionally play truant, and go off to some vacant lot and engage in a game of ball?

I confess to a strong sympathy with the intelligent truant, who loves the fields and the shore better than he does the overcrowded, ill-ventilated, and brain-prodding school-room.

The differential education of the sexes is a subject that can not

well be omitted from an address such as this purports to be, and it may well engage a little attention before I bring these remarks to a close.

And first a few words in regard to the comparative anatomy and physiology of the male and female brain.

The skull of the male of the human species is of greater capacity than that of the female, and it is a singular fact that the difference in favor of the male increases with civilization. Thus in savage nations as the Australians and the negroes of Africa, the skulls of men and women are much more alike in size than they are in Europeans. It would appear from this fact, either that women from some cause or other have not availed themselves of the advantages of civilization as factors in brain-development to the same extent as man has; or that among savages there is not that dissimilarity in mental work that is found among civilized nations, and that hence there is not the same necessity for a difference in brain-development. For it naturally follows that, in the normal skull, there is a correspondence between its size and that of the organ contained within it.

Many observations have shown that the average male brain weighs a little over forty-nine ounces, while the average female brain is a little over forty-four ounces, or about five ounces less. The proportion existing between the two is therefore as 100 : 90.

This apparently makes a good showing for man, but when we look at the matter in another, and possibly a more correct light, the advantage is rather the other way; for, relatively to the weight of the body in the two sexes, the difference, what there is, is in favor of woman. The body of the female is shorter and weighs less than that of the male. Thus, in man the weight of the brain to that of the body has been found to be an average of 1 : 36·50, while in woman it is as 1 : 36·46, a difference of ·04 in her favor. I have said that possibly this may be a more correct way of determining the size of the brain than by absolute measurements without regard to the size of the body. The doubt arises from the fact that we do not know that very thin persons, in whom of course, other things being equal, the brain would be relatively larger, are more remarkable for mental vigor than are very stout ones, in whom the relative size of the brain would be less. Such being the case, it is difficult to believe that the proportionate size of the brain to that of the body has any important influence as a factor in the production of mind. It is the absolute rather than the relative amount of gray matter that is to be considered in determining the brain-power. It must, however, be borne in mind that the quantity of gray matter can not always be positively affirmed from a determination of the size of the brain, though in *general* it can. A person, for instance, may have a large head and a large brain and the layer of cortical substance be very thin; and another person with a smaller brain may have the cortex so thick as to more than compensate for its

small superficies. Still, these are exceptional cases; as a rule, the larger the brain the greater the mental power of the individual.

Another difference between the brain of man and that of woman is found in the conformation of the organ. In man the frontal region is more developed than it is in woman. There is a certain fissure called the fissure of Rolando, which divides the brain into two unequal parts. Now, if we take the entire length of the brain as = 100, there will be found in woman 31·3 parts in front of the upper end of this fissure, while in man there will be 43·9 parts.

Again the specific gravity of the male brain, both of the white and the gray substance, is greater in man than it is in woman.

Bearing in view these differences, it is impossible to avoid the conclusion that there must also be some points of dissimilarity in the minds of the two sexes. Not necessarily that one is superior to the other, but that they are different. This is an assertion that will probably not be questioned by any one who will take the trouble to give a little reflection to the matter. We see the diversities every day—diversities of perception, of emotion, of intellect, of will. In some respects the mind of man excels; in others, that of woman is superior. It would be a bad state of things for mankind if the mind in the two primary divisions of the human race were the same. In barbarous nations, as we have seen, the difference in size is less than it is with civilized people, and as one consequence of this fact there is not so great a difference in the mental development. The work of a woman is with them almost the same as that of a man. Her mode of life, her dress are not essentially different except in so far as they must be different on account of her sex. But with civilized nations there is variety in modes of thought, in likes and dislikes, and in other mental characteristics; in occupation, in manner, in clothes, even in food, so that the differentiation between the sexes is far more distinctly marked than it is with nations low in the scale of progress. Who can doubt that this is the direct result of differences not only in the brain but in other parts of the nervous system?

It appears to me, therefore, that while the education of a woman should be just as thorough as that of a man, it ought not to be the same. The two sexes move through paths that approach parallelism at some points of their course; but they can never travel exactly the same road till they have nervous systems presenting exactly the same anatomical configuration and situation.*

Such being the case, it is the height of absurdity to attempt, what is so often attempted at the present day, the education of girls according to the same method as that pursued for boys, and giving them

* The immediately preceding paragraphs on the differences between the brains of man and woman are taken almost *verbatim* from my address entitled "The Relations between the Mind and the Nervous System," delivered at the Lehigh University on "Founder's Day," October 9, 1884, and published in "The Popular Science Monthly" for November, 1884.

almost identical studies. The effort to cram mathematics, for instance, into the female mind almost always results in failure. It is true that there have been a few women distinguished as mathematicians, but they have been so from natural predilection, and are exceptions to the general rule. I have seen many cases of girls whose nervous systems have been wofully disturbed in the endeavor to master algebra, geometry, spherical trigonometry, and other mathematical branches of knowledge that could not by any possibility be of use to them. And how many women, notwithstanding all the efforts made, have even a smattering of these subjects? Their minds revolt at the idea. Nevertheless, not only are the higher branches of mathematics kept in the curricula of many of our schools for girls, but even civil-engineering and other applied mathematical studies are pursued. I do not think that absurdity can go much further than this. They might as well include navigation; and as a woman was a short time ago licensed as captain of a Mississippi steamboat, I shall expect to hear the fact used as an argument in favor of this extension of the educational facilities for girls.

Doubtless in time the evils that I have endeavored to point out this evening will be done away with. The craze for giving every child a smattering of every branch of knowledge will disappear, but it will probably not be in our day. All the world professes to be opposed to cramming, but the system nevertheless goes on, not only unchecked, but to a greater extent year after year. The days when children really knew something well will doubtless come back, and the future teachers in medical schools will not be disgusted as I have been with the badly trained minds of many medical students who sit with gaping mouths scarcely comprehending a word of a lecture, though put in the simplest diction of the language. Pupils will then be taught to think, and not as at present to absorb without understanding.

One word more, and I have done. For the teachers, men and women, in our public and private schools, I have the most profound respect. They simply follow the system that is laid down for them, and they do it, I verily believe, with a consciousness that it is faulty in the extreme. They are, however, powerless to effect a change. At the least suggestion toward a deviation from the beaten track, school committees and commissioners of education, and, above all, blind and ignorant parents, would insist upon "the pound of flesh," "the worth of their money," and the cramming process would have to go on. To these latter our efforts at reform must be addressed. A body such as is the Nineteenth Century Club can do much toward the spread of proper ideas in regard to this important matter, and, if it sees things as I have endeavored to set them forth to-night, a mighty impulse will be brought to bear in support of a righteous cause.

# THE HISTORY OF A DELUSION.

By M. G. VALBERT.

IN the year of grace 1838, MM. d'Ennery and Anicet Bourgeois presented at the Théâtre l'Ambigu a drama entitled "Gaspard Hauser." In the same year "The Poor Idiot of the Cellar of Elberg" was played at le Gaîté, the Poor Idiot being also Gaspard or Caspar Hauser. Although he had been dead five years, impressible people still continued to be interested in the puzzle of his identity. The world had been full of his name and of the fame of his mysterious adventures, and he had been surnamed the child of Europe. To-day we French have almost forgotten him; but the Germans have not ceased to be occupied with him and to search for the solution of an enigma which has caused floods of ink to be shed, and has been the occasion of violent and abusive polemics.

In 1872, Dr. Julius Meyer published "Authentic Communications respecting Caspar Hauser." He provoked a lively response from professor Daumer, who published a new and learned study on the child of Europe, "upon his innocence, his sufferings, and his origin." He declared in it that "every good German was bound to believe in the princely origin of Caspar Hauser, and that one could not doubt it without making proof of rationalistic and satanic incredulity." In 1882 an anonymous pamphlet was published at Ratisbon which was intended to demonstrate again to the world that Caspar was the son of the Grand-duchess Stephanie, and the legitimate heir of the grand-duchy of Baden. A few years previously, the Emperor William had induced the grand-duke, his son-in-law, to shut the mouths of calumniators by publishing some documents which were preserved in the archives at Carlsruhe. The anonymous author, however, pretended to have derived his materials from important papers left by a person in a very high position, who was no other than the Grand-duchess Stephanie herself. Strong in such testimony, he had undertaken to throw light upon a long-kept secret and into the mysteries of a dark and iniquitous intrigue.

The anonymous author knew how to write and how to tell a story, and we read his book with as much interest as caution. The court of Ratisbon, trying the case, adjudicated concerning the author and his story that the famous pamphlet had been compiled from previous documents which were destitute of all authority, and that it swarmed with inexact, false, and, more than once, wild allegations. The publisher, who appealed from the judgment, was condemned to pay costs, and forced to withdraw the book from the market. A full and serious history of the pretended idiot has just been published by Herr Antonius von der Linde, in two rather overlarge octavo vulumes. Although it

was hardly worth while to give so much labor and matter to the proving Caspar Hauser to be an impostor, Herr von der Linde's volumes * will interest those who would like to know how legends are started, how they spread, and how they impose themselves on gossips, to whom the wonderful is the more charming as it is less probable.

On the 26th of May, 1828, there appeared in Nuremberg a stout, short boy, sixteen or eighteen years old, of rustic appearance, having light-chestnut hair, gray eyes, and a downy beginning of beard, and wearing a large felt hat, a jacket of dark-gray cloth, with breeches of the same, blue stockings, and hob-nailed half-boots. He had a letter without signature, addressed to Herr Friedrich von Wessenig, major in the sixth light cavalry, which read: "I send you a youth who wishes to serve, like his father, in the light-horse. He was put into my charge by his mother on the 7th of October, 1812. I am a poor day's worker, with a family to take care of. I have brought the boy up in the Christian religion, and have never let him go away from my house, so that not a soul in the world knows where he has lived till now. Do not question him on this subject, for he can not tell you anything. To keep him more in the dark, I brought him as far as Neumark in the night. He has not a sou. If you don't want to keep him, kill him, or hang him up by the chimney." This letter inclosed another one, which was regarded as of sixteen years' earlier date, on paper of similar character, and apparently in the same hand. It read in substance: "The child has been baptized, and his name is Caspar. When he is seventeen years old, send him to Nuremberg, to the light cavalry regiment. He was born on the 30th of April, 1812. I am a poor girl and can not support him, and his father is dead."

Herr von Wessenig questioned the youth, but he could not tell who he was or where he had come from. Such prodigious ignorance appeared suspicious to the major, and he sent the letters to the police commissioner, asking his advice about them. The police at first regarded Caspar as a vagabond, and he was locked up. Three points seemed to be established: that he was born on the 30th of April, 1812; that he was the illegitimate son of a poor girl and a light-cavalry man; and, as his dialect indicated, that he was a native of some part of Bavaria, near the borders of Bohemia. More than this, he had something to conceal: he had probably committed some offense, which he did not care about acknowledging to the police, and was trying to cover up his tracks. When he saw that, instead of his being enrolled in the cavalry, they were taking him to prison, he made himself appear still more simple-minded and silly than before. If they had taken a sensible course in the matter, Herr von der Linde justly observes, they could soon have cleared up the mystery; "but they did not think of looking upon the ground, and gazed into the clouds."

* Kaspar Hauser, eine neuegeschichtliche Legende, von Antonius von der Linde. Wiesbaden, 1887.

The report soon spread through Nuremberg that the police had in prison a strange being, of queer appearance, who only answered, "I don't know," to every question that was asked him. The innocent became the object of a lively curiosity, and, in a short time, of tender compassion. The public came to see him, they examined him from head to foot, and tried to make him talk. Nuremberg had at the time as its head burgomaster a very respectable, good-hearted man, of a simplicity that was easily taken in. He put himself in relations with Caspar Hauser and obtained from the mute his story of some things which he had, he said, been peremptorily forbidden to reveal. From his most tender infancy he had lived shut up in a close cellar, having two little windows that let in only a very uncertain and dim light. He had lived there for long years, dragging himself on the hard ground, without ever getting a sight of the sky, the sun, or the moon, or hearing a human voice, the song of a bird, the cry of an animal, or the sound of a footstep. His ration of food was brought to him while he was asleep; when he awoke he would perceive near his straw mat a piece of bread and a mug of water. For companions in his captivity he had nothing but a few wooden playthings.

One morning he had seen his door open, and a middling-sized man, rather poorly dressed, told him that he should know his father some day, and that he was destined to be a cavalry man as he had been, but must first learn to read and write and cipher. The unknown man came back every five days afterward to teach him the alphabet. At last, one night the unknown took him on his back, carried him out of the cellar, dressed him, and taught him how to walk. They traveled together for several days and nights, and then "the black man" gave Caspar the two letters, with his final instructions, and disappeared like a dream.

The burgomaster took the pains to tell this wonderful history to all Germany, and all Germany was moved by it. But a few brave minds refused to put any faith in it. They argued that Caspar Hauser hardly looked like a young man who had been sequestered for many years in a close, dark cellar, and that he had neither the color nor the face nor the walk of such a person. He looked well, and had a good figure and the freedom of all his limbs. Was it probable, too, that such a prisoner, who had never used his legs, had performed a march of several days and nights without the soles of his feet bearing the mark of a blister or an abrasion?

The striking contradictions between his new ways of speaking and acting, and his attitude in the first days, should also be remarked. He had come to Nuremberg with too tight boots, but they did not prevent his going and coming with ease. Other, larger ones, were given him. On putting them on, he pretended to be as awkward about them as a monkey that has to wear boots for the first time; and to be not able to stand up or to walk. When he was presented to Herr von Wes-

senig he played before the major the part of a great lubber of short wits, but still more of a sly-boots than of a fool. After he had determined to tell the story about the cellar, he affected ignorance and wonder at every thing. The sun and moon were to him new acquaintances, with which it was hard to make himself familiar, and the light troubled him. He seemed to believe that flowers and leaves and trees were made by the hands of men, and would say in his dialect: "How much time that must have taken them! Why be at so much trouble about it?" He spoke of himself in the third person, and talked to the bread that he was eating. The first time he saw a candle lighted, he asked them to give him the flame, so that he could put it on his wooden horse, which he pretended bit him sometimes. All of these things appeared suspicious to well-informed and reflecting persons, but their doubts were regarded as impious by believers. It had been decided that the wonderful story was true, and all Nuremberg believed in it. There are moral epidemics and times when nothing is less common than common sense.

Caspar Hauser, having become the adopted son of the whole city, did not stay long in prison. He was first admitted into the family of the jailer, Hiltel; then he was entertained by Professor Daumer, who regarded him as a prodigy; and then in the house of municipal Councilor Biberbach. His fame went everywhere. Members of courts and cabinets occupied themselves with his adventures. Conjecture was exhausted in the effort to discover his parents, and to pierce the mystery of his long sequestration. He was made to relate his dreams, in the hope that some light might be extracted from them. Grand personages went out of their way to visit Nuremberg in order to see and question him. Count Stanhope conceived so lively an affection for him that he wanted to take upon himself the future care of him. Masters were introduced to him who tried to take the rudeness out of him and polish him, and even to teach him Latin. Indolent, and stupid as a marmot, he complained that they were drying up his mind with the study of such trash. The only marked taste he showed was for horseback-riding, in which he excelled. He exhibited but little recognition of the cares and attentions which they put upon him. He had a low and gross mind and a hard, ungrateful heart, while his insupportable vanity, indiscreetly pampered, grew from day to day. Women doted upon him, loaded him with favors and presents, and said sweet things to him.

An incident which made considerable stir completed the demonstration to persons of a willing disposition on the subject that Caspar Hauser was a young man of high lineage, and that his unknown persecutors had a large interest in bringing about his disappearance. On the 17th of October, 1829, while he was lodging with Professor Daumer, he was surprised in a closet by a black man (*un homme noir*), who struck him in the forehead with a sharp instrument, and went

away, saying, "You shall die before you go away from Nuremberg!" Caspar recognized in this man the same person who had taken him out of the cellar, and who doubtless wished to punish him for having broken silence and told his story to the gossiping burgomaster. Nobody but Caspar had seen this black man, who seemed to have vanished in the air like smoke, after having struck the youth. Search was instituted for him, and inquisitions were made to recover traces of him; but no news was had of him. From that day, however, due pains were taken to protect the child of Europe against the assassins who were watching for him; and he never went out without an escort of two guards.

These precautions were relaxed little by little, and some time after this Caspar left Nuremberg and went to reside at Anspach, under the care and at the expense of Count Stanhope. He became a boarding-pupil of schoolmaster Meyer, whom he caused much annoyance. On the 14th of December, 1833, as he was walking alone in the Public Garden, he was again accosted by a black man, who presented him with a purse; and he was at the same time struck on his left side with a dagger. The purse contained a note written in a back hand, and reading: "Hauser will be able to describe my appearance to you, and tell you where I came from. To save him the trouble, I will tell you myself: I came from the frontier of Bavaria. I will tell you my name, too: M. L. O." The second assassin was as indiscoverable as the other one. Unfortunately, the wound was graver than was thought at first, and Caspar died on the 17th of December, having exclaimed, "O God, God! must I die thus in shame and disgrace?"

There was at the time in Berlin a counselor of police named Merker, a very methodical, exact, logical man, whose sagacity it was hard to outwit. Struck with the accumulation of improbabilities in the stories of Caspar Hauser, he drew the conclusion from them that "either we must believe in miracles, or Caspar is an impostor." "It will be said some day, in some course of universal history," he wrote, "that a young man appeared one evening in a German city as if he had fallen from a star; but the sky was not his country; he had come out of an underground dungeon, and saw daylight now for the first time. A mysterious unknown had brought him out of his hole, and this unknown was at the same time his jailer, his master, his tutor, his deliverer, and the man commissioned to assassinate him. The police of the city of Nuremberg found something queer in this story, and regarded the miraculous child as a very ordinary vagabond. But the world soon became occupied with him. They wrote books and a great many articles in the journals about him. The extraordinary being became the object of profound scientific researches. His saliva, his urine, his evacuations were learnedly analyzed; his ways of acting, even his sneezings, were studied and commented upon as if they were affairs of state. If any one ventured to express a doubt, he was dishonored and

despised; and a miraculous event was learnedly explained by other events still more miraculous."

A circumstance that confirmed Merker's suspicions and skepticism was the fact that everybody who had anything to do with Caspar Hauser surprised him, at some time or another, in some flagrant lie. Madame Biberbach wrote, on the 19th of February, 1832: "How many bitter hours has this child made us pass! How many griefs and vexations has he caused us by his absolute want of truthfulness! When we catch him in the act, he pretends to repent, and promises to amend, and we begin to love him again; but the demon of falsehood has so fully taken possession of him that he is always falling back into his sin, and going deeper and deeper into his vice. From the time when he saw himself detected his heart was estranged from us." Count Stanhope, who had loved him as a father, began to grow cool toward him and to mistrust him. After having dreamed of the most brilliant career for him, his illusions dispelled, he had no better thought for him than to find him employment with some large stable. Merker inferred from these facts that the miraculous child, seeing his high hopes failing and uneasy about his future, had felt the necessity of bringing back his benefactors, and of fortifying their wavering faith by a new comedy; that he had invoked the phantom of the black man, in which Count Stanhope did not more than half believe, for the second time; that the assassin of Caspar Hauser was Caspar himself; that he had struck himself with the dagger, but had struck too hard; that he was the victim of his own maladroitness, and that his death was an involuntary suicide.

The idle populace reasoned very differently from the suspicious and sagacious police counselor. They believed more than ever in the black man, and in the noble origin of Caspar Hauser. They had made him by turns the son of a village curate, or of a canon, or bishop, or baron, or count, or Hungarian magnate. They now held it for certain that he was born in a palace, that his mother had reigned somewhere, and that faithless collaterals had seized the heritage of the child of Europe. Suspicion shortly fastened upon the house of Baden, and the bell was so well fixed to it that it tinkles even yet at the slightest breath of gossip that blows over Carlsruhe.

The Margrave Charles Frederick, who became grand-duke in 1806, was married twice. After the death of the Princess Caroline, of Hesse-Darmstadt, he concluded a morganatic union with Madame Hochberg, countess of the empire, who was born Geyer von Geyerberg. His successor was his grandson Charles, who married Stephanie Louise Adrienne de Beauharnais, a lady who had been brought up by the Emperor Napoleon, with the rank of a princess of France. She had five children, of whom two sons died, one a few days, the other a few months, after birth. The former, born on the 29th of September, 1812, died on the 16th of October of the same year; the second lived from

the 1st of May, 1816, to the 8th of May, 1817. By the death of these two princes the succession passed to Louis I, uncle of the Grand-duke Charles, and after him to the descendants of the second marriage—to the morganatic line which now reigns in Carlsruhe. Those were found who could imagine and affirm that the prince born in 1812 was not dead, but that persons interested in his disappearance had caused him to be abducted, and had substituted for him another child who had shortly died, and that the stout boy who, on the 26th of May, 1828, presented himself, letter in hand, before Major Friedrich von Wessenig, was the real grand-ducal heir of Baden, who had been shut up for sixteen years.

This legend, revamped from the history of Cyrus, Romulus, and other great heroes, was hard to digest. Substitutions of children are attended by difficulties, especially when the child in question is a royal or nearly royal scion, an heir that has been ardently expected and impatiently waited for, and whose features have been fondly looked upon. On the 4th of October, 1812, the grandmother of the little prince, the Margravine Amelia of Baden wrote in French to her daughter, the Empress Elizabeth of Russia: "The wife of Charles was brought to bed on the 29th of September, with a son of enormous size in proportion to his mother's; it cost much trouble and suffering, too, to get him into the world. The event has caused much joy here." The grandmother examined the child closely, for on the 11th of October she wrote again to her daughter: "Everything is in joy here over the birth of an heir; what gives me the most pleasure about it is, that I find in him a resemblance to his father when he was a baby." But this rejoicing was of short duration. On the 18th of October, at eleven o'clock in the morning, the margravine took up the pen again, "to announce the death of the poor little one. . . . He only lived for seventeen days, with a vigor and healthfulness which made us hope for his preservation; but he was all at once seized with suffocation and convulsions in the head. . . . Charles is very much affected by it; I never saw him so much afflicted. I am grieved, because the child was so like the house of Baden. I was obliged to announce it yesterday morning to his mother, who was not anticipating anything of the kind. No one else would take it upon himself." She added, on the 25th of October, "The death of that child, who interested me because of the resemblance I found in him to the house of Baden, and whom I saw expire, . . . and the extreme grief of Charles—all that has overthrown me."

The grandmother saw the child born and saw him die; the father was there, too, and the nurse. The corpse was examined and opened in the presence of the state minister, Berckheim, and nine doctors. No one suspected substitution. Shall we believe that everybody was in the plot, including even the grandmother? No one has ventured to maintain this. It was once pretended that the man in the iron mask

was the Count of Vermandois, a natural son of Louis XIV, who died, to the knowledge of the public, in the army, of small-pox, in 1683, and that they buried a stake to personate him, over which Louis XIV had a solemn service performed. It is easier to believe in this stake than to contemn a grandmother.

An improbable story will not make its way in the world unless it is patronized by some grand personage, who has an interest in accrediting it. No one contributed more to propagate the legend of Caspar Hauser than King Louis I of Bavaria, who bore little good-will to his neighbors in the west. His father, Maximilian Joseph, had promised himself to annex the Badenese palatinate to his states, and had concluded for that purpose a secret treaty with Austria in 1815. Men always dislike those whom they have not succeeded in despoiling. King Louis would have been very ready to discredit the descendants of the second marriage, who had mounted the throne in 1830, in the person of the Grand-duke Leopold I. The occasion seemed a good one for him to question the validity of their rights, and to insinuate to Europe that they had come to power through an abominable conspiracy, and that the legitimate heir was the stout boy whom he had harbored in his good city of Nuremberg. To please him, it was necessary to swallow the story with the eyes shut and the mouth wide open. Skeptics and cavilers evidently disobliged him.

Whether by compliance or for love of the marvelous, some persons in high circles were inclined to believe in Caspar. The painter Greil painted his portrait in pastel; he represented him as he saw him—that is, as an unprepossessing rustic of low physiognomy. The portrait was engraved, and the engraver transformed the rustic into a Prince Charming. The Princess Royal of Prussia, who was only acquainted with the engraving, wrote, in 1832, to Queen Caroline of Bavaria, sister of the Grand-duke Charles: "The portrait of this young man has vividly interested me. . . . I do not know whether it may not be the effect of my smitten imagination, but it seems that I find some resemblance between Hauser's features and those of your poor brother. . . . This face troubles me like a specter." But it was, above all, important to persuade the mother, the Grand-duchess Stephanie, and win her over to the good cause. Suffering greatly from the effects of a severe labor, she had seen little of her child; she had not witnessed his death; and it is very tempting to a mother to believe that her son is not dead. Caspar Hauser was frequently spoken of to her, and she was persuaded to have him brought to her, in the hope that her heart might tell her something. She shook her head, and continued incredulous. The celebrated jurist, Mittermaier, Professor of Law at Heidelberg, had a conversation with her on the subject. She declared to him that the abduction of her son and the substitution of another child was "a pure impossibility." "My mother," wrote the Duchess of Hamilton, "never believed a word of that story. That King Louis

tried to persuade her to it is another matter. As to myself, I always answered that I held to the judgment of my mother, who has often said, like the old margravine, 'It is impossible.'"

But King Louis had on his side all the malcontents of the grand-duchy. Every gaming-master who complained of a denial of justice, every solicitor who had been refused, avenged his injury by saying, "Caspar Hauser became inconvenient to you, and you had him assassinated." The name of the mysterious personage who was supposed to have conducted the affair was boldly given, and Count Stanhope was accused of having been a go-between in the crime. The field was beaten for proofs of the accusations. Time and again some sharp-witted man in want of money would send word to the court of Carlsruhe that he was the possessor of secret papers in which the tragic adventure was related from point to point. He would ask for a large sum, and they would give nothing, and then he would publish his papers. Persons of keen scent and reading could recognize in his little work whole chapters from old *factums*, which had fallen into oblivion, and scenes extracted from a romance by Seybold, which was no longer read. Such, according to Herr von der Linde, was the history of the famous pamphlet of 1882, on which the tribunal of Ratisbon executed justice.

Merker reduced the question to these terms: We know nothing of Caspar Hauser except what it has pleased himself to tell us, and no one ever passed a week with him without surprising him more than once in a lie. What credit does a story deserve that is founded on the testimony of a downright liar? But believers would object: Is it possible to suppose that a young man of an uncultivated and very narrow mind should have a genius for invention, and that he could maintain his imposture to the end without betraying himself or departing from his assumed part? To this the doubters replied: that the public had kindly taken it in hand to facilitate his task for him, and open the way for him, which he had not even had to take the trouble to mark out. Some one has said that in France the first day is for infatuation, the second for criticism, and the third for indifference. The infatuation of the people of Nuremberg seems to have been more enduring than usual; for the days of criticism and indifference never came for Caspar Hauser.

There are two kinds of cunning. One, which sometimes has genius in it, composes in advance a grand plan, conforms all its conduct to it, and prepares afar off, for its adversaries, traps which shall be sprung suddenly and surely. That is the cunning of Ulysses and the politicians. Caspar Hauser had nothing but the passive cunning of the chameleon, which changes color to agree with the objects around it. He accommodated himself to circumstances; he lent himself with unlimited compliance to the desires and prejudices of his benefactors, and he worked upon their prepossessions and their open credulity.

Schoolmaster Meyer represented him as a man of robust body, ready with his hands, and of a more pliant mind than was generally thought, divining quickly enough with whom he was dealing, and governing his face and language accordingly. He came to Nuremberg without any other intention than to become a light cavalry man. He found people disposed to believe that he was a hero of romance and the victim of a dark conspiracy. He entered into their idea, and invented the childish story of the dungeon. People regarded him as simple-minded, and spoke freely before him. He took advantage of all that he heard, and was what they wanted him to be. The relative facility with which he played his part may be explained still more easily if we suppose, with Merker, that he had escaped from a traveling circus, where he had gained some knowledge of the art of riding horseback, and had learned to compose his face for the diversion of the idlers in the interludes. It is said that in the last months of his life he had conceived a project of making the tour of Europe, going from city to city, and making a show of himself. Such a way of getting a living suited him much better than the employment which Count Stanhope proposed. The natural man appeared again, and prevailed over the studied part.

The honest people who allowed themselves to be taken in by the story of the dungeon were never willing to give it up. To them it was as the last word of the gospel. It is hard to recant, and acknowledge that one has been duped. We have seen in Paris a mathematician of eminent merit holding as authentic letters in which Pascal taught attraction previous to Newton, and continuing to believe in those letters when no one else believed in them. We have seen in Prussia an illustrious Egyptologist recommending to the Academy of Sciences, as a work of incalculable value, a Greek manuscript fabricated by a forger, in which he found confirmation of some of his boldest conjectures; and it cost much trouble to make him acknowledge his error. The eminent criminalist, Anselm Feuerbach, who joined to a warm spirit and vivid imagination a taste for subtile ratiocinations and the art of deciphering the secrets of hearts, could not decipher Caspar Hauser. From the first day he regarded him as a miracle, and, having said it once, it was of no use to try to make him unsay it. "This dear foundling," he wrote to a friend in 1830, "has been for years the principal object of my studies, researches, and cares. An inhabitant of Saturn, falling during the night into the imperial city of Nuremberg, would not be enveloped in more mystery." He finally decided that Caspar Hauser was a Badenese prince, and till his death he was, with King Louis, the most zealous champion of the legend.

On the other side, physiologists and moralists, convinced that a young man who had passed sixteen years in the solitude of a dungeon might furnish valuable lessons respecting the primordial laws of human nature, studied him with devoted attention. Some thought that they could discover in him all the signs of the "animal man," and

noted them down carefully. Others, persuaded, with Rousseau, that we are born good and pure, and that it is society that perverts us, went into ecstasies "before the miraculous innocence of this paradisiacal youth, the image of Adam before the fall." A homœopathic physician, Dr. Preu, discovered that infinitesimal dilutions had prodigious effects on this primitive being. He only had to open his medicine-case or uncork one of his vials to make the compliant Caspar fall into a swoon; and Hahnemann, hearing of the phenomenon, declared that the child of Europe was the living demonstration of homœopathy and the confusion of its enemies. The same Dr. Preu, laying it down as an axiom that "in a man who had passed his youth in a cellar the telluric principle ought to prevail over the solar principle," employed days and weeks in studying the action of metals and minerals on the nervous system of Caspar. He declared that jasper chilled his arm to the elbow, and chalcedony to the shoulder. Caspar lent himself obligingly to these varied experiments. He was told: "You should feel this; you should feel that." His answer would be, "I feel it." And Dr. Preu carefully registered his observations and analyses, as documents worthy of passing down to the most distant posterity. If the impostor had been unmasked, homœopathists, moralists, philosophers, theologians, and jurists would have been covered with ineffaceable ridicule. When they kept guard over the legend, it was to protect their self-respect against scoffers.

Herr von der Linde has more than proved that Caspar Hauser was not a grand-duke. It appears further from his book that of all the adventurers who have at any time imposed themselves on the attention of the world and forced it to hear their name; of all fraudulent heroes; of all intruders upon fame, Caspar was the least interesting and the nakedest of prestige and charm and grace. The greatest mark of wisdom that he gave was to die at twenty years of age.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

## ASTRONOMY WITH AN OPERA-GLASS.

### THE STARS OF SPRING.

By GARRETT P. SERVISS.

THERE was never a time when the heavens were studied by so many amateur astronomers as at present. In every civilized country many excellent telescopes are owned and used, often to very good purpose, by persons who are not practical astronomers, but who wish to see for themselves the marvels of the sky, and who occasionally stumble upon something that is new even to professional star-gazers. Yet, notwithstanding this activity in the cultivation of astronomical studies, it is probably safe to assert that hardly one person in a hun-

dred knows the chief stars by name, or can even recognize the principal constellations, much less distinguish the planets from the fixed stars. And of course they know nothing of the intellectual pleasure that accompanies a knowledge of the stars. Modern astronomy is so rapidly and wonderfully linking the earth and the sun together, with all the orbs of space, in the bonds of close physical relationship, that a person of education and general intelligence can offer no valid excuse for not knowing where to look for Sirius or Aldebaran, or the Orion nebula, or the planet Jupiter. As Australia and New Zealand and the islands of the sea are made a part of the civilized world through the expanding influence of commerce and cultivation, so the suns and planets around us are, in a certain sense, falling under the dominion of the restless and resistless mind of man. We have come to possess vested intellectual interests in Mars and Saturn, and in the sun and all his multitude of fellows, which nobody can afford to ignore.

Perhaps one reason why the average educated man or woman knows so little of the starry heavens is because it is popularly supposed that only the most powerful telescopes and costly instruments of the observatory are capable of dealing with them. No greater mistake could be made. It does not require an optical instrument of any kind, nor much labor, as compared with that expended in the acquirement of some polished accomplishments regarded as indispensable, to give one an acquaintance with the stars and planets which will be not only pleasurable but useful. And with the aid of an opera-glass most interesting, gratifying, and, in some instances, scientifically valuable observations may be made in the heavens. I have more than once heard persons who knew nothing about the stars, and probably cared less, utter exclamations of surprise and delight when persuaded to look at certain parts of the sky with a good glass, and thereafter manifest an interest in astronomy of which they would formerly have believed themselves incapable.

Being convinced that whoever will survey the heavens with a good opera-glass will feel repaid many fold for his time and labor, the present writer has undertaken to point out some of the objects most worthy of attention, and some of the means of making acquaintance with the stars.

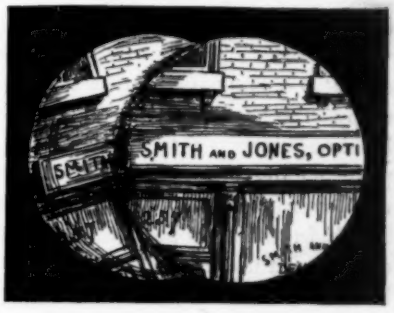
First, a word about the instrument to be used. Galileo made his famous discoveries with what was, in principle of construction, simply an opera-glass. This form of telescope was afterward abandoned because very high magnifying powers could not be employed with it, and the field of view was restricted. But, on account of the brilliant illumination of objects looked at, and its convenience of form, the opera-glass is still a valuable and, in some respects, unrivaled instrument of observation.

In choosing an opera-glass, see first that the object-glasses are achromatic, although this caution is hardly necessary, for all modern

opera-glasses are made with achromatic objectives. But there are great differences in the quality of the work. If a glass shows a colored fringe around a bright object reject it. Let the diameter of the object-glasses, which are the large lenses in the end farthest from the eye, be not less than an inch and a half. The magnifying power should be at least three diameters. A familiar way of estimating the magnifying power is by looking at a brick wall through one barrel of the opera-glass with one eye, while the other eye sees the wall without the intervention of the glass. Then notice how many bricks seen by the naked eye are required to equal in thickness one brick seen through the glass. That number represents the magnifying power.

The instrument used by the writer in making most of the observations for this sketch has object-glasses 1·6 inch in diameter, and a magnifying power of about three and one half times.

See that the fields of view given by the two barrels of the opera-glass coincide, or blend perfectly together. If one appears to partially overlap the other when looking at a distant object, the effect is very annoying. This fault arises from the barrels of the opera-glass being placed too far apart, so that their optical centers do not coincide with the centers of the observer's eyes.




Occasionally, on account of faulty centering of the lenses, a double image is given of objects looked at, as illustrated in the accompanying cut. In such a case the glass is worthless; but if the effect is simply the addition of a small, crescent-shaped extension on one side of the field of view without any reduplication, the fault may be overlooked, though it is far better to select a glass that gives a perfectly round field. Some glasses have an arrangement for adjusting the distance between the barrels to suit the eyes of different persons, and it would be well if all were made adjustable in the same way.

Don't buy a cheap glass, but don't waste your money on fancy mountings. What the Rev. T. W. Webb says of telescopes is equally true of opera-glasses: "Inferior articles may be showily got up, and the outside must go for nothing." There are a few makers, whose names stamped upon the instrument, may generally be regarded as a guarantee of excellence. But the best test is that of actual performance. I have a field-glass which I found in a pawn-shop, that has no maker's name upon it, but is quite capable of bearing critical comparison with the work of the best advertised opticians. And this leads me to say that, by the exercise of good judgment, one may occasionally purchase superior glasses at very reasonable prices in the

pawn-shops. Ask to be shown the old and well-tried articles; you may find among them a second-hand glass of fine optical properties. If the lenses are not injured one need not trouble himself about the worn appearance of the outside of the instrument; so much the more evidence that somebody has found it well worth using.

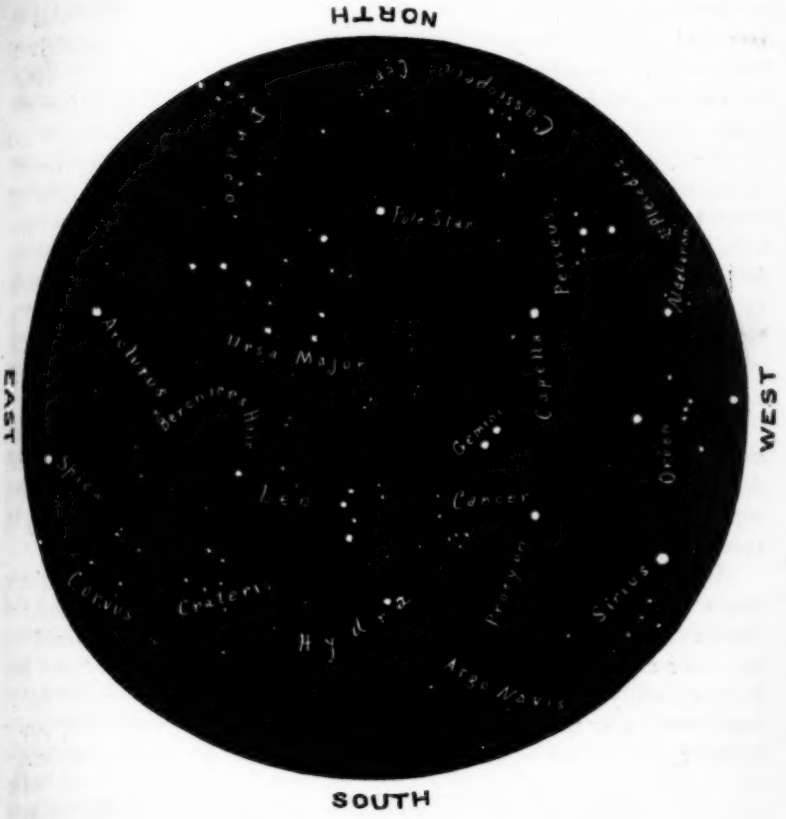
A good field or marine glass is in some respects better than an opera-glass for celestial observations. It possesses a much higher magnifying power, and this gives sometimes a decided advantage. But, on the other hand, its field of view is smaller, rendering it more difficult to find and hold objects. Besides, it does not present nearly as brilliant views of scattered star-clusters as an opera-glass does. For the benefit of those who possess field-glasses, however, I have included in this brief survey certain objects that lie just beyond the reach of opera-glasses, but can be seen with the larger instruments.

Having selected your glass, the next thing is to find the stars. Of course, one could sweep over the heavens at random on a starry night and see many interesting things, but he would soon tire of such aimless occupation. One must know what he is looking at in order to derive any real pleasure or satisfaction from the sight.

The circular map here given represents the appearance of the heavens, at 9 o'clock P. M., on or about the 1st of April. The center of the map is the zenith, or point overhead. The reader must now exercise his imagination a little, for it is impossible to represent the true appearance of the concave of the heavens on flat paper. Holding the map over your head, with the points marked East, West, North, and South in their proper places, conceive of it as shaped like the inside of an open umbrella, the edge all around extending clear down to the horizon. Suppose you are facing the south, then you will see, up near the zenith, the constellation of Leo, which can be readily recognised on the map by six stars that mark out the figure of a sickle standing upright on its handle. The large star in the bottom of the handle is Regulus. Having fixed the appearance and situation of this constellation in your mind, go out-of-doors, face the south, and try to find the constellation in the sky. With a little application you will be sure to succeed.

Using Leo as a basis of operations, your conquest of the sky will now proceed more rapidly. By reference to the map you will be able to recognize the twin stars of Gemini, southwest of the zenith and high up; the brilliant lone star, Procyon, south of Gemini; the dazzling Sirius, flashing low down in the southwest; Orion, with all his brilliants, blazing in the west; red Aldebaran and the Pleiades off to his right; and Capella, bright as a diamond, high up above Orion, toward the north. In the southeast you will recognize the quadrilateral of Corvus, with the singularly white star Spica glittering near the horizon east of it.

Next face the north. If you are not just sure where north is,




try a pocket-compass. This advice is by no means unnecessary, for there are many intelligent persons who are unable to indicate true north within many degrees, though standing on their own doorstep. Having found the north point as near as you can, look upward about forty degrees from the horizon, and you will see the lone twinkler called the north or pole star. Forty degrees is a little less than halfway from the horizon to the zenith.

By the aid of the map, again, you will be able to find, high up in the northeast, near the zenith, the large dipper-shaped figure in Ursa Major, and, when you have once noticed that the two stars in the outer edge of the bowl of the Dipper point almost directly to the pole-star, you will have an unfailing means of picking out the latter star hereafter, when in doubt.* Continuing the curve of the Dipper-handle, in the northeast, your eye will be led to a bright-reddish star, which is Arcturus, in the constellation Boötes.

* Let the reader remember that the distance between the two stars in the brim of the bowl of the Dipper is about ten degrees, and he will have a measuring-stick that he can apply in estimating other distances in the heavens.

In the same way you will be able to find the constellations Cassiopeia, Cepheus, Draco, and Perseus. Don't expect to accomplish it all in an hour. You may have to devote two or three evenings to observation, and make many trips indoors to consult the map, before you have mastered the subject; but when you have done it you will feel amply repaid for your exertions, and you will have made for yourself silent friends in the heavens that will beam kindly upon you, like old neighbors, on whatever side of the world you may wander.

Having fixed the general outlines and location of the constellations in your mind, and learned to recognize the chief stars, take your opera-glass and begin with the constellation Leo and the star Regulus. Contrive to have some convenient rest for your arms in holding the glass, and thus obtain not only comfort but steadiness of vision. A lazy-back chair makes a capital observing-seat.

You will at once be gratified by the increased brilliancy of the star as seen by the glass. If the night is clear it will glow like a diamond. Yet Regulus, although ranked as a first-magnitude star, and of great repute among the ancient astrologers, is far inferior in brilliancy to such stars as Capella and Arcturus, to say nothing of Sirius.

By consulting the little map of the constellation Leo, here given, you will next be able to find the celebrated star bearing the name of the Greek letter Gamma (γ). If you had a telescope, you would see this star as a close and beautiful double, of contrasted colors. But it is optically double, even with an opera-glass. You can not fail to see a small star near it, looking quite close, if the magnifying power of your glass is less than three times. You will be struck by the sur-

LEO

prising change of color in turning from Regulus to Gamma—the former is white and the latter deep yellow. It will be well to look first at one and then at the other, several times, for this is a good instance of what you will meet with many times in your future surveys of the heavens—a striking contrast of color in neighboring stars. You will

then comprehend that there is more than one sense in which to understand the Scriptural declaration that "one star differeth from another in glory." Turn next to the star in the map of Leo marked Zeta ($\zeta$). If your glass is a pretty large and good one, and your eye keen, you will easily see three minute companion stars keeping company with Zeta, two on the southeast, and one, much closer, toward the north. The nearest of the two on the south is faint, being only between the eighth and ninth magnitude, and will probably severely test your powers of vision. Next look at Epsilon ($\epsilon$), and you will find near it two seventh magnitude companions, making a beautiful little triangle.

Away at the eastern end of the constellation, in the tail of the imaginary Lion, upon whose breast shines Regulus, is the star Beta ($\beta$) Leonis, also called Denebola. It is almost as bright as its leader, Regulus, and you will probably be able to catch a tinge of blue in its rays. South of Denebola, at a distance of nineteen minutes of arc, or somewhat more than half the apparent diameter of the moon, you will see a little star of the sixth magnitude, which is one of the several "companions" for which Denebola is celebrated. There is another star of the eighth magnitude in the same direction from Denebola, but at a distance of less than five minutes, and this you may be able to glimpse with a powerful field-glass, under favorable conditions. I have seen it well with a field-glass of 1·6-inch aperture, and a magnifying power of six times.

When looking for a faint and difficult object, the plan pursued by telescopists is to avert the eyes from the precise point upon which the attention is fixed, in order to bring a more sensitive part of the retina into play than that usually employed. Look toward the edge of the field of view, while the object you are seeking is in the center, and then, if it can be seen at all with your glass, you will catch sight of it, as it were, out of the corner of your eye. The effect of seeing a faint star in this way, in the neighborhood of a large one, whose rays hide it from direct vision, is sometimes very amusing. The little star seems to pop out into view as through a curtain, perfectly distinct, though as immeasurably minute as the point of a needle. But the instant you direct your eyes straight at it, presto! it is gone. And so it will dodge in and out of sight as often as you turn your eyes.

If you will sweep carefully over the whole extent of Leo, whose chief stars are marked with their Greek-letter names on our little map, you will be impressed with the power of your glass to bring into sight many faint stars in regions that seem barren to the naked eye. An opera-glass of 1·5 aperture will show ten times as many stars as the naked eye can see.

Looking now westwardly from the Sickle of Leo, at a distance about equal to twice the length of the Sickle, your eye will be caught by a small silvery spot in the sky lying nearly between two rather faint stars. This is the famous Præsepe, or Manger, in the center of the

constellation Cancer. The two stars on either side of it are called the Aselli, or the Ass's Colts, and the imagination of the ancients pictured them feeding from their silver manger. Turn your glass upon the Manger and you will see that it consists of a crowd of little stars, so small and numerous that you will probably not undertake to count them, unless you are using a large field-glass. Galileo has left a delightful description of his surprise and gratification when he aimed his telescope at this curious cluster and discovered what it really was. Using his best instrument, he was able to count thirty-six stars in the Manger. The Manger was a famous weather-sign in olden times, and Aratus, in his "Diosemia," advises his readers to—

> ". . . watch the Manger: like a little mist
> Far north in Cancer's territory it floats.
> Its confines are two faintly glimmering stars;
> These are two asses that a manger parts,
> Which suddenly, when all the sky is clear,
> Sometimes quite vanishes, and the two stars
> Seem to have closer moved their sundered orbs.
> No feeble tempest then will soak the leas;
> A murky manger with both stars
> Shining unaltered is a sign of rain."

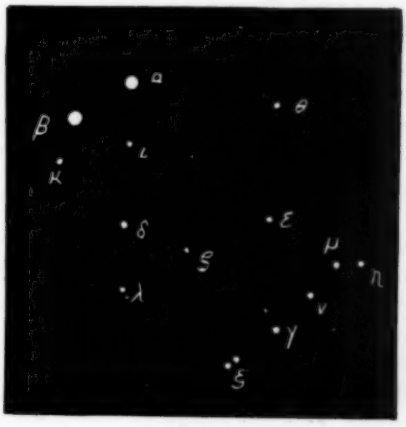
Like other old weather-saws, there is probably a gleam of sense in this, for it is only when the atmosphere is perfectly transparent that the Manger can be clearly seen; when the air is thick with mist, the harbinger of coming storm, it fades from sight.

Below the Manger, a little way toward the south, your eye will be caught by a group of four or five stars of about the same brightness as the Aselli. This marks the head of Hydra, and the glass will show a striking and beautiful geometrical arrangement of the stars composing it. Hydra is a very long constellation, and trending southward and eastward from the head it passes underneath Leo, and, sweeping pretty close down to the horizon, winds away under Corvus, the tail reaching to the eastern horizon. Its stars are all faint, except Alphard, or the Hydra's Heart, a second-magnitude star, remarkable for its lonely situation, southwest of Regulus. A line from Gamma Leonis through Regulus points it out. It is worth looking at with the glass on account of its rich orange-tint.

Coming back again to the Manger as a starting-point, look well up to the north and west, and at a distance somewhat less than that between Regulus and the Manger you will see a pair of first-magnitude stars, which you will hardly need to be informed are the celebrated Twins, from which the constellation Gemini takes its name. The star marked $\alpha$ in the map is Castor, and the star marked $\beta$ is Pollux. No classical reader needs to be reminded of the romantic origin of these names.

A sharp contrast in the color of Castor and Pollux comes out as

soon as the glass is turned upon them. Castor is white, with occasionally, perhaps, a suspicion of a green ray in its light. Pollux is deep yellow. Castor is a celebrated double star, but its components are far too close to be separated with an opera-glass, or even the most powerful field-glass. You will be at once interested by the singular *cortége* of small stars by which both Castor and Pollux are surrounded. These little attendant stars, for such they seem, are arrayed in symmetrical groups—pairs, triangles, and other figures—which, it seems difficult to believe, could be unintentional, although it would be still more difficult to suggest any reason why they should be arranged in that way.




GEMINI

Our little map of Gemini will show you the position of the principal stars of the constellation. Castor and Pollux are in the heads of the Twins, while the row of stars marked in the map Zi ($\xi$), Gamma ($\gamma$), Nu ($\nu$), Mu ($\mu$), and Eta ($\eta$), marks their feet, which are dipped in the edge of the Milky-Way. One can spend a profitable and pleasurable half-hour in exploring the wonders of Gemini. The whole constellation, from head to foot, is gemmed with stars which escape the naked eye, but it sparkles like a bead-spangled garment when viewed with the glass. Owing to the presence of the Milky-Way, the spectacle around the feet of the Twins is particularly magnificent. And here the possessor of a good opera-glass can get a fine view of a celebrated star-cluster known in the catalogues as 35 M. It is situated a little distance northwest of the star Eta, and is visible to the naked eye, on a clear, moonless night, as a nebulous speck. With a good glass you will see two wonderful streams of little stars starting, one from Eta and the other from Mu, and running parallel toward the northwest; 35 M is situated between these star-streams. The stars in the cluster are so closely aggregated that you will be able to clearly separate only the outlying ones. The general aspect is like that of a piece of frosted silver over which a twinkling light is playing. A field-glass will bring out more of the component stars. The splendor of this starry congregation, viewed with a powerful telescope, may be guessed at from Admiral Smyth's picturesque description: "It presents a gorgeous field of stars, from the ninth to the sixteenth magnitude, but with the center of the mass less rich than the rest. From the small stars being inclined to form curves of three or four, and often with a large one at the root of the curve, it somewhat reminds one of

the bursting of a sky-rocket." And Webb adds that there is an "elegant festoon near the center, starting with a reddish star."

No one can gaze upon this marvelous phenomenon, even with the comparatively low powers of an opera-glass, and reflect that all these swarming dots of light are really suns, without a stunning sense of the immensity of the material universe.

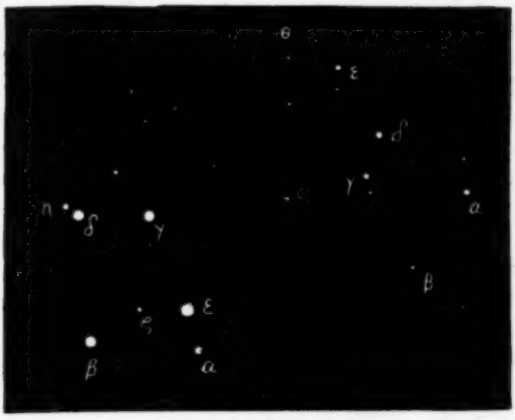
The Twins are just now entertaining a visitor whose presence may cause some perplexity to the beginner in star-lore. The planet Saturn, in his great thirty-year journey around the sun, is passing nearly through the center of this constellation. You will see the planet a little west of the star marked Delta (δ) in the map of Gemini, and making a conspicuous triangle with Castor and Pollux. It outshines both of those stars, but its golden light is more steady than theirs. Turn your glass upon it, and the difference in the aspect of a planet and that of a star will at once become apparent.

The map will enable you next to find Procyon, or the Little Dog-Star, more than twenty degrees south of Castor and Pollux, and almost directly below the Manger. This star will interest you by its golden-yellow color and its brightness, although it is far inferior in the latter respect to Sirius, or the Great Dog-Star, which you will see flashing splendidly far down beneath Procyon in the southwest. About four degrees northwest of Procyon is a third-magnitude star, called Gomelza, and the glass will show you two small stars which make a right-angled triangle with it, the nearer one being remarkable for its ruddy color.

Sirius, Orion, Aldebaran, and the Pleiades, all of which you will perceive in the west and southwest, are generally too much involved in the mists of the horizon to be seen to the best advantage at this season, although it will pay you to take a look through the glass at Sirius. But the beautiful star Capella, in the constellation Auriga, may claim a moment's attention. You will find it high up in the northwest, halfway between Orion and the pole-star, and to the right of the Twins. It has no rival near, and its creamy-white light makes it one of the most beautiful as well as one of the most brilliant stars in the heavens. Its constitution, as revealed by the spectroscope, resembles that of our sun, but the sun would make but a sorry figure if removed to the side of this giant star. About seven and a half degrees above Capella, and a little to the left, you will see a second-magnitude star called Menkalina. Two and half times as far to the left, or south, in the direction of Orion, is another star of equal brightness to Menkalina. This is El Nath, and marks the place where the foot of Auriga, or the Charioteer, rests upon the point of the horn of Taurus. Capella, Menkalina, and El Nath make a long triangle which covers the central part of Auriga. The naked eye shows two or three misty-looking spots within this triangle, one to the right of El Nath, one in the upper or eastern edge of the constellation, near a third-magnitude star called Theta, and another on a

line drawn from Capella to El Nath, but much nearer to Capella. Turn your glass upon these spots, and you will be delighted by the beauty of the little stars to whose united rays they are due.

El Nath has around it some very remarkable rows of small stars, and the whole constellation of Auriga, like that of Gemini, glitters with star-dust, as the Milky-Way runs directly through it.




CORVUS AND CRATERIS.

Let us turn back again to Denebola in the Lion's Tail. Now glance from it far down into the southeast, and you will see a brilliant star flashing not far above the horizon. This is Spica, the chief twinkler of Virgo, and you will find it marked on our circular map. Then look into the northwest, and at about the same distance from Denebola, but higher above the horizon than Spica, you will catch the sparkling of a large, reddish star. It is Arcturus in Boötes. The three, Denebola, Spica, and Arcturus, mark the corners of a great equilateral triangle. Nearly on a line between Denebola and Arcturus, and somewhat nearer to the former, you will perceive a curious twinkling, as if a cobweb spangled with dew-drops were hanging there. One might think the old woman in the nursery rhyme who went to sweep the cobwebs out of the sky had skipped this corner, or else that its delicate beauty had preserved it even from her housewifely instincts. This is the little constellation called Berenice's Hair. Your opera-glass will enable you to count twenty or thirty of the largest stars composing this cluster, which are arranged, as so often happens, with a striking appearance of geometrical design. This constellation has a very romantic history. It is related that the young Queen Berenice, when her husband was called away to the wars, vowed to sacrifice her beautiful tresses to Venus if he returned victorious over his enemies. He did return home in triumph, and Berenice, true to her vow, cut off her hair and bore it to the Temple of Venus. But the same night it disappeared. The king was furious, and the queen

wept bitterly over the loss. There is no telling what might have happened to the guardians of the temple, had not a celebrated astronomer named Conon led the young king and queen aside in the evening and showed them the missing locks shining transfigured in the sky. He assured them that Venus had placed Berenice's lustrous ringlets among the stars, and, as they were not skilled in celestial lore, they were quite ready to believe that the silvery swarm they saw near Arcturus had never been there before. And so for centuries the world has recognized the constellation of Berenice's Hair. These time-honored legends, that have delighted the brightest minds in all countries and all ages, lend an interest of their own to the starry heavens, in spite of the fact that they make no impression upon the armor-plated souls of certain mathematicians who pretend to be the only astronomers, and who would sweep all constellations and mythologies together into limbo.

Look next at Corvus and Crateris, two little constellations which you will discover on the circular map, and of which we give a separate representation. You will find that the stars Delta ($\delta$) and Eta ($\eta$), in the upper left-hand corner of the quadrilateral figure of Corvus, make a striking appearance. The little star Zeta ($\zeta$) is a very pretty double for an opera-glass. There is a very faint pair of stars close below and to the right of Beta ($\beta$). This forms a severe test. Only a good opera-glass will show these two stars as a single faint point of light. A field-glass, however, will show both, one being considerably fainter than the other. Crateris is worth sweeping over for the pretty combination of stars to be found in it.

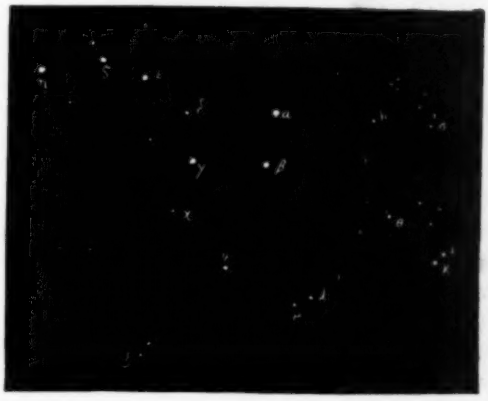
Arcturus and Spica, and their companions, may be left for observation to a more convenient season, when, having risen higher, they can be studied to better advantage. It will be well, however, to merely glance at them with the glass in order to note the great difference of color—Spica being brilliantly white and Arcturus almost red. We will now turn to the north. You have already been told how to find the pole-star. Look at it with your glass. The pole-star is a famous double, but its minute companion can only be seen with a telescope. As so often happens, however, it has another companion for the opera-glass, and this latter is sufficiently close and small to make an interesting test for an inexperienced observer armed with a glass of small power. It must be looked for pretty close to the rays of the large star, with such a glass,

URSA MINOR.

and, at nine o'clock in the evening, is below the large star. It is of the seventh magnitude. With a large field-glass several smaller companions may be seen, and a very excellent glass may show an 8·5 magnitude star almost hidden in the rays of the seventh magnitude companion.

With the aid of the accompanying map of Ursa Minor, which is the constellation to which the pole-star belongs, find the star Beta ($\beta$), which is also called Kochab (the star marked $\alpha$ in the map is the pole-star). Kochab has a pair of faint stars nearly north of it, about one degree distant. With a small glass these may appear as a single star, but a stronger glass will show them separately.

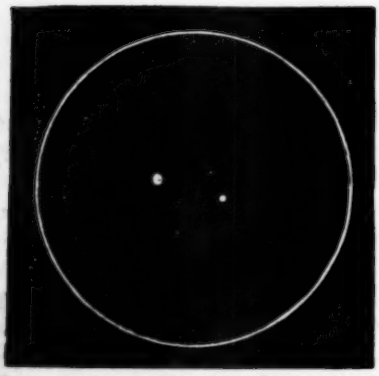
And now for Ursa Major and the Great Dipper—Draco, Cepheus, Cassiopeia, and the other constellations represented on the map, being rather too near the horizon for effective observation at this time of the year. First, as the easiest object, look at the star in the middle of the handle of the Dipper (this handle forms the tail of Ursa Major), and a little attention will show you, without the aid of a glass, if your eyesight is good, that the star is double. A smaller star seems to be almost in contact with it. The larger of these two stars is called Mizar and the smaller Alcor—the Horse and his Rider the Arabs said. Your glass will, of course, greatly increase the distance between Alcor and Mizar, and will also bring out a clear difference of color distinguishing them. Now, if you have a very powerful glass, you may be able to see the Sidus Ludovicianum, a minute star which a German astronomer discovered more than a hundred and fifty years ago, and strangely enough, taking it for a planet, named it after a German prince. The position of the Sidus Ludovicianum with reference to Mizar and Alcor, is represented in the accompanying sketch. You must look very sharply if you expect to see it, and your opera-glass will have to be a large and strong one. A field glass, however, can not fail to show it.



URSA MAJOR.

Sweep along the whole length of the Dipper's handle, and you will discover many fine fields of stars. Then look at the star Alpha ($\alpha$) in the outer edge of the bowl nearest to the pole-star. There is a faint star, of about the eighth magnitude, near it, in the direction of Beta ($\beta$). This will prove a very difficult test. You will have to try it with averted vision. If you have a field-glass, catch it first with

that, and, having thus fixed its position in your mind, try to find it with the opera-glass. Its distance is a little over half that between Mizar and Alcor. It is of a reddish color.



MIZAR, ALCOR, AND THE SIDUS LUDOVOCIANUM.

You will notice nearly overhead three pairs of pretty bright stars in a long, bending row, about half-way between Leo and the Dipper. These mark three of Ursa Major's feet, and each of the pairs is well worth looking at with a glass, as they are beautifully grouped with stars invisible to the naked eye. The letters used to designate the stars forming these pairs will be found upon our little map of Ursa Major. The scattered group of faint stars beyond the bowl of the Dipper forms in the Bear's head, and you will find that also a field worth a few minutes' exploration.

But, after all, no one can expect to derive from such studies as these any genuine pleasure or satisfaction unless he is mindful of the real meaning of what he sees. The actual truth seems almost too stupendous for belief. The mind must be brought into an attitude of profound contemplation in order to appreciate it. From this globe we can look out in every direction into the open and boundless universe. Blinded and dazzled during the day by the blaze of that star, of which the earth is a near and humble dependent, we are shut in as by a curtain. But at night, when our own star is hidden, our vision ranges into the depths of creation, and we behold them sparkling with a multitude of other suns. With so simple an aid as that of an opera-glass, we penetrate still deeper into the profundities of space, and thousands more of these strange, far-away suns come into sight. They are arranged in pairs, sets, rows, streams, clusters—here they gleam alone in distant splendor, there they glow and flash in mighty swarms. This is a look into heaven more splendid than the materializing imagination of Bunyan pictured; here is a celestial city whose temples are suns, and whose streets are the pathways of light.

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A COLLECTION of drawings by the Jesuit botanist, Camelli (1661–1706), illustrating his lists of plants of the Island of Luzon in Ray's "Historia Plantarum," exists in good preservation in the library of the Jesuits' College at Louvain. It contains two hundred and fifty-seven autograph plates, with five hundred and fifty-six figures of plants, and three plates, with nine figures relating to zoölogy. It was obtained at the sale of the library of Jussieu, and bears annotations in his handwriting.

# SOCIAL AND PHYSIOLOGICAL INEQUALITY.

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THE subject of the hour is the social problem. Viewed in the light of the pressing questions demanding settlement—questions really of life and death—the new science of sociology overshadows all others in importance. The air is full of the angry clamor raised by different cliques and classes, all arguing from the standpoint of their own interests. The strain to which society is thus subjected must be relieved, if possible, by broad and unprejudiced reasoning in the line of causes. In this manner only can the possibilities and limitations of relief be suggested. It is evident that in the present state of society many are hopelessly worsted in the effort to gain, not a competency, but a moderate sustenance. Numerous irrelevant causes and cures are constantly being proclaimed for this glaring evil, leaving the essential causes untouched. The mutterings of discontent heard on all sides have their basis largely in the belief that the fault lies in a friction resulting from an artificial social order. Economic laws are really, at bottom, the outcome of physiological laws and conditions. Assuredly, laws of Nature are fundamental and must underlie economic laws; the latter may be modified, but not essentially altered by artificial social relations. Certain reformers are fiercely attacking our social system as the ultimate cause of misery, entirely overlooking the fact that social conditions are merely the resultant and aggregate of individual characteristics. As long as these remain unchanged, society may be repeatedly disintegrated, but the same abuses will as regularly spring up. Those who are demanding more social equality must first see to it that there is more individual equality. It is a favorite corollary of our political system that all men are born equal. Unfortunately, legal equality is not physiological equality. In fact, there is no such thing as equality. Much of the restlessness of the age is the endeavor to institute formulas and laws of equality while no such real element exists. Two stupendous factors are present in all life, physical as well as mental—heredity and environment. These all-controlling influences are present, for good or evil, in varying proportions in different lives. With the generation of life heredity, whose mysterious effects we must recognize without understanding, has done its best or worst for the beginning existence; its potency has been in the past, acting perhaps through long reaches of time. With commencing life comes in the new element of environment, as the complement of heredity, to enhance the evil trait, or perhaps obliterate it; too often to sow the seeds of physical and mental weakness in a constitution that was given

a healthy start. To insure correct environment and habit, particularly in the early years of life, is of vital importance to the well-being and efficiency of the individual. This, unfortunately, is not, and in many cases can not, be done. Hence the fearfully unequal physical, mental, and moral equipment of mankind, that allows the minority to have too much, the majority too little, of the world's necessities and comforts.

This question, however, has a broader interest than is merely involved in economics. One of the ultimate aims of life upon earth is the perpetuation of the species, an essential incident of which is the struggle to live. This aim of life in Nature is seen in all creations, from trees and insects up to man. Under the term "struggle of life" are included many complex factors. Such problems as how to conserve and prolong life, how to lower the death-rate in children, how to produce good hereditary development, how to strengthen the bodies and minds and enlarge the spiritual bounds of men—all these, and many other questions, are included in a conception of this struggle. It is evident that those are the best conditions of life that lead to the highest development of the physical, mental, and moral faculties, and the largest and best growth of the species. The all-important question is this: How are the present conditions of society favoring and how subverting a successful struggle on the part of many of its members? How far do they tend to cripple the best development of life? This larger and more absorbing question includes the narrower one we are here discussing, as to the observed inequalities of society. It is too large a theme for a single essay. A brief glance at the varying conditions that produce social inequality may be of interest.

1. Unequal Physical Development.—As a rule, the more bodily vigor a person possesses the better will be his chance of getting on in the world. Many people fail because they have not the physical strength for prolonged and successful effort. What fair chance, then, has a child beginning life in an overcrowded tenement-house, all of whose bodily functions are from the first contaminated? The cells, of which the human body is but an aggregate, might at this time by healthy surroundings and physiological living, have marked upon them an impress of lasting vigor; by foul air and improper nourishment they likewise have sown in them the seed of an early degeneration. After a large dispensary experience, I have no hesitancy in saying that the great majority of children brought up in the tenement-houses of New York are, in greater or less degree, affected by a constitutional taint, usually scrofulous or rachitic. Such a vicious condition grows by what it feeds on. Each generation will get worse from the addition of hereditary influences to the faulty environment, unless something is done to check these evils. It is not difficult to foresee what will result in a community if a large proportion of its inhabitants are, by reason of their physical organization, seriously handicapped in the struggle

for existence. The dirt and discomfort, in the midst of which thousands live at our very doors, would astound many among the better classes who are always wondering at the shiftlessness of the poor. A suggestive paper was read before the British Medical Association in 1885, showing the large influence that bodily comfort has in lowering the death-rate. The same influences that can increase mortality among the poor are also operative in curtailing their efficiency and usefulness.

2. Unequal Mental Development.—Some of our modern materialistic philosophers would have us believe that mind is a function of body—a sort of secretion of the brain. While this bald conception will not commend itself to many, it certainly is true that mind acts through nervous organization, the integrity of which stands in a direct relation to the most efficient mental manifestation. In the physical growth of man a completely developed brain is the highest type of organization. The normal action of the mind is much modified by the health or disease of the nervous elements, which are constantly affected by the condition of the vital organs. As a rule, therefore, an efficient mind is an accompaniment of a well-acting body. It is true that brute strength is frequently seen accompanied by signs of only inferior mental life, but in such cases the evolution of the higher nerve-centers, together with proper education of the mind, has been in abeyance for generations, with resulting stagnation. In the intensely close competitions of the present day a certain mental acumen is absolutely necessary to attain any measure of success. The man who has not the mental equipment to figure a close bargain will as inevitably succumb to the one who can, as the bird with the longest beak or strongest claw will vanquish its weaker antagonist. The physically and mentally weak inevitably yield before the law of the survival of the fittest in our modern civilization. This law may be more immediately apparent in its action on physical than on mental life, yet it is as real in one as in the other sphere. Hereditary taint and bad hygienic surroundings produce in many such a condition of weak lungs as to develop, by the ordinary and necessary exposure of life, the disease known as consumption. Death results, and such people die because their lungs are not fit, or strong enough, to survive in the conditions of their environment. Our dispensaries and hospitals are now crowded with such unfortunates who are bound to succumb, sooner or later, to this unerring natural law. Persons with vigorous lungs, who can do the world's work and thrive under conditions that destroyed the former class, are living examples of a physical survival of the fittest. But there is just as much a mental as a physical exemplification of this law. The dull wit can not be made to accomplish that which is easily done by the acute mind—can not live the same life. A man who digs a canal must, in order to do the only thing within his capacity for earning a living, become the tool of the mentally "fitter" man—the engineer—who has the intellectual skill to plan such a work. Disgusted at his

uneven lot, the laborer would often strike down the man whose mental superiority makes possible the earning of his bread. Trades-unions in attempting to reduce all work and wages to a dead level, in spite of the varying abilities of different workingmen, are striving to accomplish a reversal of natural law. As for any permanent success in this matter, they will find it about as difficult to change the operation of the law of the survival of the fittest, as the law of attraction of gravitation. A state or society might as well decree that the man with the strong lungs should not live any longer than the one with weak lungs, as attempt to restrain the fertile, active mind, and limit its performance by the capacity of the dull brain. At the same time, we should strive to find out the preventable causes of mental as well as of physical inferiority.

The child from the swarming tenement-house, after a desultory and unpractical schooling, is quickly transferred to shop or factory, where the struggle of life must be begun on a pitiably insufficient physical and mental training. A practical, industrial education does not appear to be within the conception of our public schools. This is just the line of education that would make them useful to the poor. We are hearing much at present of the dignity of manual labor; but work of the hands, unless in a measure directed by the head, is rather a lame accomplishment. Workingmen often show an inability to get along, because they have not sufficient mental equipoise to direct their affairs properly, as well as their work. They are continually being victimized by political manipulators and social quacks from this cause. Social conditions that keep men and women hopelessly toiling all their lives on one low plane are lamentable, but biological law shows us that heredity and a terribly unfavorable environment have of necessity precluded the physical and mental acuteness necessary to reach a higher level.

3. Unequal Moral Development.—In character, no less than in body and mind, do we see vast differences among men. From the perfect activity of a well-balanced will to the uncertain energy of a vacillating character, there are innumerable variations. Such gradations do not stand in any ratio to intellectual culture. Moral power depends largely upon material environment. It does not flourish with filth or famine. Self-respect, that fundamental necessity for the higher attributes, can not well exist in rags and dirt. Moral rectitude is with difficulty conserved when the contact of individuals is too close. The excessive overcrowding so often seen in the tenements of great cities is as destructive of virtue as of physical health. I have seen sexual diseases engendered, even in childhood, that will not only cripple the development of the individual, but be propagated to future generations. Probably the most prolific cause of vice in densely populated centers is the condition here noted. This is only one aspect of a great subject. It is not necessary to believe that moral nature has been

acquired by the slow processes of evolution to appreciate the preponderating influence of heredity in the manifestation of will-power and kindred phenomena. Two individuals may start in life apparently with equal chances and hindrances. One succeeds, the other fails; one is only stimulated by obstacles, the other is disheartened and conquered by them; one has inherent possibilities in his nature that are utterly absent in the other. The mysterious potentialities of different natures are often more easy of recognition than of explanation. There are many peculiar and diverse ways in which the action of the moral nature is exhibited, according to its development, in human affairs. Thus some men display most exemplary conduct in certain relations of family and society, but show an utter absence of the moral sense in dealing with competitors.

There are, unfortunately, at the present time, too many object-lessons exemplifying a strangely irregular moral development. Men who calmly exhibit the greatest depravity in pushing schemes for their own interest, recklessly bribing officials and buying legislators, may yet show apparently the record of a most proper private life. A man who wrecks a bank, thereby spreading distress and ruin wide-spread, is found to be the kindest of fathers. The evil done by forcing a corner in the market that will put some of the necessaries of life beyond the reach of the needy multitude, can not be compensated for by subscribing to a charity. Railroad-wrecking and dishonest speculation form an incongruous mixture with benevolence. Qualities that are subversive of all civic virtues and tend to the very disintegration of society, appear to flourish by the side of a sort of goodness, finding expression, perhaps, in one or two directions.

The faculty of the mind, as well as the organ of the body, that is used the most, undergoes the highest development and works with preponderating efficiency. If there is an absence of a properly regulated human and moral feeling to hold a check on such excessive keenness, the results are unfortunate. The over-development of acquisitiveness and the under-development of certain moral faculties, have enabled individuals to distance competitors and crowd better men to the wall. Some men may have too high a sense of honor to compete successfully with others not so endowed. Doubtless, many of the shiftless and lazy like to consider that they are too honest to succeed. But often this is true of better men. Intense selfishness is too exclusively the mainspring of endeavor in our modern civilization. While the inferior development of physical and mental functions keeps a large proportion of mankind in unequal subjugation to the minority, the under-development of certain parts of the moral nature is actually an aid to worldly success. This is a pregnant thought, and shows how the development theory can throw side-lights on all angles of a social question.

There is, then, a direct relation between an individual's heredity and

environment and the complete soundness and efficiency of that individual. In the struggle for existence, where all the conditions for successful and vigorous life have unavoidably been present in poorest degree, it inevitably follows that competition with more vigorous minds and bodies must result in hopeless defeat. Hence the absurdity of most of the ideas advanced for the relief of social wrongs. Appeals are being continually made to Government to remedy this unfortunate state of affairs. But Government can not help or prevent the operation of natural law. These laws of Nature have been permanently established by the Deity, and no set of men acting temporarily as figure-heads of society can alter their operation. Human life, to be satisfactory, must be conducted according to a knowledge and in conformity with these laws. All that Government can do and should do is to strive to furnish and insist upon the most favorable natural conditions or environment possible for the people—in other words, give them the best chance. Beyond this, nothing can be done by Government. It can not alter a man's ancestors. The Scriptures, as well as the state, tell us to work out our own salvation.

No altered laws will compensate for defective knowledge or will-power in the regulation of human affairs. A man or a sect with a panacea is always popular. It is disagreeable to face the fact that the causes of most of the ills of life are complex and often difficult of removal. Universal specifics are thus numerous. The statement that people like to be humbugged is as true of social as of physical ills. They shift from one to another of the many quacks who can point to a single and sure road out of all their troubles. Two leading theories have been advanced to reorganize society—socialism and communism. As a sentiment, socialism is in keeping with the highest conception of the relation of man to man ; as an organization, it is the enemy of society, since it is not in correlation with the present structure and development of human nature. The underlying sentiment of socialism claims that every man should have a fair opportunity to make a comfortable living and a chance to develop what is best in himself and family. At present this is impossible in many cases. It will continue to be impossible until the weak can be strengthened by more favorable environment for a more efficient struggle in life.

Communism recognizes the evils resulting from the fearfully unequal distribution of wealth, and would force a general division. As human nature is now constituted, this is an idle conception. The wealth that is universally distributed and equalized to-day will to-morrow be again in the hands of the few. Legislators can not prevent this unerring economic law due to fundamental differences in men's development and equipment. Beer-garden philosophers would bring everybody to a level—the lowest level—well exemplified in themselves. In the different strata of society, if men could only be leveled from below up in physical and mental weakness and inefficiency; from above

down in unscrupulous sharpness with lacking moral sense, society would be in a condition of more stable equilibrium. No radical alteration in social order will be possible until human nature has slowly been prepared for it by a corresponding alteration. Social reconstruction must be preceded by a reconstruction of man's nature. Has modern society, then, nothing to answer for? Can it calmly point to the inexorable laws of evolution as responsible for social wrongs? Assuredly not. Society must be held in a measure responsible for the crippling environment of so many of its members. The labor that is treated as a pure commodity, to be purchased in the lowest market, will be apt to sink to that level. The manufacturer sees in the excessive division of labor a way to quick profits; hence even pins must be made, from head to point, by different artisans. This plan may produce sharp pins, but it makes dull men, whose children will probably be duller yet.

Trades-unions and labor organizations sin more in this respect, however, than the greediest capitalists. The leaders by sternly repressing all efforts of the men to better their condition, by checking all ambition to become skillful, by stopping apprentices from learning trades, and by striving to produce a general level of remuneration, are reducing laborers to the condition of slaves.

Modern industrial civilization is adapted to make the sharp sharper and the dull duller, which is only another way of saying concentration of wealth and diffusion of poverty. Society should strive to atone for its fearful inequalities, not by division and almsgiving, but by strengthening the weak for more successful effort. It must aid the poor and unfortunate by giving them a chance to help themselves. Giving to charities is esteemed generous; it is a truer generosity for the keen man of affairs not to ruinously undersell his less acute neighbor and thus perhaps force him to depend on charity. Above all, no social relief that is not based upon essential causes can be permanently successful. Social reformation that is not in harmony with the underlying laws of Nature will always be a failure. It must follow in the lines indicated by a logical study of the sciences of biology, physiology, and even of pathology. Social law must conform to natural law. All artificial adjustments only complicate existing troubles in leaving untouched the real causes of these troubles. If several men are in a boat that capsizes, all will struggle to reach the shore, but the man who can not swim will sink, although all the legislatures of the world forbid death by drowning. He sinks in obedience to a natural law, attraction of gravitation, the operation of which, to his destruction, he is not expert enough to avoid in an unaccustomed environment. If society will prevent such accidents, it must do it in the natural way of strengthening its members and teaching them how to swim, plainly showing the possible consequences of such a neglect, and not by issuing fiats against misfortune. This is the natural as distin-

guished from the artificial method of dealing with a social question. A persistent struggle for continuous and successful life, with intervening accidents or catastrophes, always possible, forms the ever-present condition of physical as well as of social living. Much of our daily energy is necessarily expended in repairing continual bodily waste that the process of life entails, in fighting off disease or avoiding accidents. Life can truly be defined as a struggle for existence. With reference to life in society, Carlyle, in his terse, strong style, puts it thus: "No man lives without jostling and being jostled; in all ways he has to elbow himself through the world, giving and receiving offense. His life is a battle, in so far as it is an entity at all." Sociology must try and determine why many fight such a losing battle, by seeking closer counsel with the laws and teachings of physiology.

The lazy, inefficient, and even the criminal classes, are an inevitable by-product of our complex modern civilization. They are not accidents, but accretions. They are developed by laws that it is the duty of social science to discover and obviate, instead of indulging in idle moralizing. These laws must be evolved by a slow and patient study of social phenomena interpreted by biological methods. When these laws are understood, it will be seen that a sound education is the measure of relief. I use this word in no narrow or conventional sense, but meaning the development of the whole being in the line of the highest strength and efficiency of the various parts. Every effort of the philanthropist, the social reformer, and the Government must be invoked to prevent degradation and degeneration in the poorer classes, and raise them to a better status. The laws of healthy development must be taught, and the consequences of their neglect in the habits of life be shown.

A young man who will marry early and raise a large family in a closely populated center will inevitably involve himself in poverty and his family in misery. Such apparent facts must be laid before the young in time to prevent mistakes that can not be rectified. One of the unfortunate factors in the social question is that the poorest and often the physically unfittest classes are usually the most prolific, for which they sometimes receive needless and undeserved praise. It is the business and duty of Government to do all in its power to prevent or mitigate any environment that all experience shows will produce not only physical and mental inefficiency, but sufficient degradation of the moral sense to make criminals. To this extent can Government profitably interfere in a social question. It may be contended that Government is not a philanthropic institution, and hence it is without its scope to consider means to elevate the shiftless and unfortunate. It may also be argued that Government can not consistently interfere even with the degradation of people without assuming a right to regulate all their affairs. But, outside of all theoretical objections, no one

will deny the right and duty of Government to look out for itself. Self-preservation is a law that applies to governments as well as to individuals. Any factors that threaten the stability of organized society, threaten at the very same time the very existence of governments. Hence, when scientific and hygienic laws show that certain environments degrade and degenerate men, they must be prevented, although appearing to interfere with the liberty of the subject. No legal shibboleth must be allowed to stand in the way of such action. Government in its function of preserving itself, and looking out for the best good of the majority, must prevent a minority from living in any way it can take cognizance of that plainly lessens their health and efficiency.

In spite of caste, society is homogeneous. One section can not suffer long without affecting all. If one part is much diseased, the healthy part will sooner or later feel the infection. More equable health will equalize opportunity. Political communism is a dream of agitators. The toiling, weary, worsted masses look in vain to such a chimera. Deliverance must come from within. Our popular agitators are impatient of a few weeks' delay in righting the wrongs of society. Reform of this kind that is measured by months is superficial and uncertain. Nature in progressing is prodigal of time, but operates with certainty and thoroughness.

## INFECTION AND DISINFECTION.

By ROBSON ROOSE, M. D.

THE enormous variety of subjects contained in medical literature necessitates the use of a corresponding number of terms, the majority of which have a certain and well-known meaning; but it would be difficult to find two words more wanting in the element of precision, and more loosely used, than those placed at the head of this article. The general public, indeed, solve all difficulties by connecting with the word infection the idea of something "catching," i. e., something that can be propagated from one person to another, and disinfection is correspondingly regarded as the means whereby such propagation can be hindered. It must be admitted that this simple view is quite correct so far as it goes. It of course disregards all questions as to the nature of infection, and the reason why some diseases spread from person to person and others do not, and it accepts without doubt the belief that disinfection is generally attainable, and by comparatively simple means. In cases especially where the use of some well-advertised material is found to neutralize or mask an unpleasant odor, the completeness of the disinfection is looked upon as absolutely certain.

In medical writings the confusion has been still further increased

by the use of the words "contagion" and "contagious" in describing those diseases which were considered to spread from one person to another by contact. "Infection" and "infectious" were limited to the cases in which the poison of the disease was supposed to be conveyed by the atmosphere from the sick person to those at a greater or less distance from him. Accordingly, we used to hear of a disease being contagious but not infectious, and *vice versa*. The distinction is, however, a purely artificial one, and is not sustained by facts, for many of the contagious diseases can be propagated indirectly—that is, without actual contact between the person who yields the poison and the person who receives it. Take, for example, diphtheria: it assuredly spreads by contact, and is therefore contagious, and no less positively is the poison capable of being disseminated through the atmosphere and infecting those who inhale it. So, too, with small-pox. If its virus be introduced under the skin of a person unprotected by vaccination or a previous attack, he will almost certainly suffer from the disease, and the same result would follow were such a person to be in close attendance upon a small-pox patient. In the latter case, the poison floating about in the atmosphere would get into the system through the lungs, and this is practically just as much an example of *contact* as if the poison were artificially introduced through the skin. It is therefore better to consider the terms "infection" and "contagion" as practically synonymous, and they will be so used in the remarks that follow.

To show what is implied by an infectious disease, let me take a typical example and contrast it with another disorder well known to be non-infectious. A young adult, previously in good health, is suddenly attacked by such symptoms as chilliness, soreness of throat, and evidences of derangement of the stomach. There is nothing characteristic about these symptoms; but let us suppose that on the following day there are high fever, dryness of skin, headache, giddiness, etc., and that in a few hours a scarlet rash appears, first on the chest, and then spreads over the body. All the symptoms become worse, and for ten or twelve days the patient is very ill. After this period, in favorable cases, a change takes place for the better, the rash dies away, and all the other symptoms gradually subside. In from four to six weeks, supposing that there are no complications, the patient regards himself as well. Such, in a few words, is the course of a mild case of scarlet fever, which may be considered as a typically infectious disease. Now suppose that our patient is treated in a house where there are several other young people who have never suffered from the disease. We know from experience that unless the most minute precautions are taken, the majority of these persons will exhibit similar symptoms. It is also well known that if any of these patients, supposed to have partially recovered from the disease, change their place of abode and go among other friends, the latter will run great risk of being attacked,

and that the disease may thus spread *ad infinitum*. This capacity of propagation, the possession of which is as certain as anything can possibly be, suggests the inquiry as to the manner in which the original patient of our series became infected. He in his turn must have taken the disease from some one else, but it is quite possible that he has never been within a mile of a scarlet-fever patient. In many such instances it is impossible to get any clew to the original case, but it sometimes happens that evidence is forthcoming to the effect that days or weeks, or even months before, a person convalescent from the disease has occupied a room of which our patient was afterward a tenant, or that some article of clothing which once belonged to patient number one has been handled or worn by the person whose case we are considering. It is evident that there must often be great difficulties in prosecuting such an inquiry.

Let us now take an example of a non-infectious disease, and notice how it contrasts with the one we have just described. A young adult, previously in good health, becomes sensible of a feeling of heat, alternating with chilliness, and perhaps shivering, and slight pains in the limbs. In a day or two there is more or less fever and thirst, and some of the larger joints are swollen and very painful, while the skin covering them is much reddened. The pain and fever are the principal symptoms; but there are often others, a description of which is unnecessary for our present purpose. The complaint lasts an indefinite time, but, even in the absence of treatment, usually subsides within six weeks. Such, in a very few words, is the course of rheumatic fever or acute rheumatism.

These two diseases, scarlet fever and rheumatic fever, have much in common, but there are sharp points of difference between them. In both fever is a prominent symptom, and, in addition to the display of local symptoms, the whole system is evidently affected. The differences, however, are still more important. Scarlet fever is eminently infectious. The air which surrounds the patient becomes contaminated and highly charged with the poison, and persons breathing it run great risk of becoming affected. In a case of rheumatic fever, although the secretion from the skin is generally very copious and peculiar in character, so that the sense of smell is strongly appealed to, there is no such risk; the disease can not be conveyed from the patient to those around him, however close the attendance and however defective the ventilation of the room. Infection from a previous case is, therefore, never thought of in connection with rheumatic fever, though the actual nature of the poison which causes the disease is as yet unknown. The attack is often excited by exposure to cold and wet, circumstances which play no part in the causation of scarlet fever. There is at least one more important difference between the two diseases: scarlet fever very rarely, indeed, occurs a second time in the same patient, and the symptoms never become chronic; rheumatic fever, on

the other hand, is very prone to recur, and in not a few cases the original attack merges into a chronic state of suffering, which may continue for months or even years.

I have taken scarlet fever as a representative of the class of infectious diseases, the cause of which is the contamination of the system by some specific poison, and I have sketched in a few words the main symptoms which result. For our present purposes the important points are the contagious or infectious character of the disease, and the proofs that the contagious material multiplies within the system which it has invaded, and from which it sallies forth in quest of other victims. There are, unfortunately, not a few diseases belonging to the same category as scarlet fever, the principal being small-pox, measles, typhus, influenza, whooping-cough, diphtheria, typhoid, and cholera. With regard to all these it may be stated that they are all separate and distinct as regards causation. A case of scarlet fever never gives rise to small-pox in those exposed to infection, neither does any one of the above diseases ever pass into another. There are other subordinate distinctions: the poison of scarlet fever, contained presumably in detached particles of skin, clings for months to articles of clothing, especially woolen ones; that of small-pox may be collected from the eruption and preserved for years between pieces of glass; that of typhus is easily rendered innocuous by free ventilation. All these peculiarities—and many more might be cited—point to important differences in the nature of the infectious materials.

What this infectious material really is has often been keenly debated since medicine became a science, and at the present time is the question which most closely occupies the minds of medical investigators. Merely to enumerate the inquiries, and to describe the experiments and the theories based thereon, would fill a volume; but it is not to be wondered at that this subject should have excited so much attention when we reflect upon the prevalence and fatality of the diseases in question, and upon the comparatively slight influence which treatment exercises upon their course. On the other hand, experience clearly shows that their prevention is not only possible, but in some cases easily accomplished. The knowledge of the causes of these diseases would indicate the proper preventive measures, or at any rate the direction which such measures should take, and hence a discovery of the cause in any given case at once yields practical results. When we know what causes infection, we can apply disinfection with every prospect of success. Without such knowledge success, if attained, must be accidental rather than otherwise. The nature of the contagious agencies, and the medium through which they spread, are the most important points in connection with the subject of infection.

There is strong evidence in support of the view that these contagia are actual living things. Formerly the opinion was universally held that infectious diseases were caused by foul air, and the effluvia con-

nected with putrid decomposition were regarded as a sufficient cause for the development of fever, small-pox, etc. It can not be denied that gaseous matters, notably sulphureted hydrogen, may act as poisons and cause many serious symptoms, but it has never been shown that infectious diseases originate in this manner. It is contrary to all that chemistry teaches us, that sulphureted hydrogen or ammoniacal vapors inhaled by the lungs should increase within the body and cause it to become a center of infection; and we know likewise that ordinary poisons—e. g., arsenic or morphia—fatal as their effects may be to one individual, have no power of increase and propagation after being once taken. It is therefore evident that the poisons of infectious diseases must be something of an entirely different nature. We know that they multiply in the system to an almost infinite extent, and that every one of the myriads of atoms thus developed is as potent for evil as the atom from which it originated. The possession of this and other properties clearly indicates that the contagious agencies are independent living organisms, capable of growth and reproduction. It has long been known that certain diseases of the skin—e. g., ringworm—are caused by the presence of parasites, which very rapidly increase, and can be easily recognized under the microscope.

In the case of some three or four of the infectious diseases it would seem that the poison has really been discovered. On examining vaccine matter, the contents of the pocks in small-pox, and discharges in glanders, the microscope shows a vast number of infinitely minute particles, which appear as glistening points. Some of these are even less than the fifty-thousandth of an inch in diameter, and it therefore follows that very high powers are necessary for their detection. Such particles, obtained from vaccine lymph, have been washed in water; the water when inoculated did not produce any effect, but the washed particles were found to have retained their potency. It seems fair to infer that the contagious agents of the other infective diseases would resemble in their physical characters that of vaccine, and the nature of such particles is the important problem that offers itself for solution. They are supposed by some, and notably by Dr. Beale, to be of an animal origin, and to consist of elementary living matter, termed *bioplasm*. Such particles may be easily transferred from an infected to an uninfected organism, in which they will manifest their own specific powers, and grow and multiply almost indefinitely, exciting in their new home a series of changes resembling those which characterized their presence in the one from which they were derived. This account is certainly correct as regards the virus of vaccine, but it does not precisely define the nature of the particles or tell us anything of their origin. Dr. Beale, however, states that particles of contagious bioplasm are not generated in the organism of the infected animal, but are introduced from without, and were originally derived by direct descent from the bioplasm of the body of man or animal. He regards

them in fact as particles of degraded bioplasm. This theory is not in favor, or rather is not fashionable, at the present time. One objection to its validity is constituted by the fact that particles of living animal matter die very rapidly after they have escaped from the body, whereas many contagious germs preserve their vitality and capacity for evil for a very long time.

Another theory which was promulgated some twenty years ago was to the effect that the contagious particles are of the nature of those low vegetable organisms which are termed *fungi*. This view gains support from the manner in which these bodies increase in number when planted in a suitable soil, and the power which they possess of decomposing many organic substances. The fact, already referred to, that several diseases of the skin and hair in men and animals are undoubtedly due to fungi, also tends to recommend this theory. Recent experiments, however, have shown that these organisms, capable as some of them are of growth and development on the *surface* of the body, do not possess the power of growth and reproduction *within* the body, and it is therefore unlikely that they should be the causes of disease in which the system is charged with poisonous materials.

A third theory is one which is extremely popular at the present day, advocated as it is by investigators of the highest repute. It is almost needless to say that I refer to the view which credits certain minute organisms, termed *bacteria*, with the power of causing the infectious diseases—that is, with being in themselves the poisonous agents. So firm is the hold that this view has obtained that "disease-germs" and "bacteria" are used as though they were synonymous terms. It is, moreover, probable that more experiments have been made with reference to bacteria than on any other subject whatever.

The term "bacterium" signifies a rod, and many of these organisms are minute, rod-shaped bodies. They or their germs are very widely diffused throughout nature; they swarm in the air and in water, especially if containing organic matter, and are likewise found in great numbers within the bodies of men and animals. Any one who possesses a microscope with a magnifying power of five hundred diameters can readily examine a very common form of bacterium. It is only necessary to take a glass of ordinary water from a spring or river, and to leave it in a room exposed for some days to the air. A thin coating, looking like a deposit of fine dust, is formed on the surface of the water; this dust consists of myriads of bacteria, which are readily seen when a drop of the water is examined. The bacteria are found to be in several stages of transformation: some are in long, jointed rods, others represent one or more detached portions of these rods, and others appear as extremely minute, rounded particles. The rods are capable of movement, and they are seen to wriggle through the fluid like small eels or snakes. The minute, rounded particles are the spores, which eventually become rod-shaped bodies.

The peculiar interest connected with this simple experiment is due to the fact that minute organisms closely resembling those just described are found in the bodies of patients suffering from acute infectious diseases, and the question naturally arises as to the relation which exists between the organisms and the symptoms. Are the former the cause of the latter, or is their presence a mere coincidence? Another suggestion is that their presence is the result of the disease. If the symptoms are really caused by the presence and action of the bacteria, it would follow that differences must exist between the organisms found in different diseases. Great and manifold difficulties attend such investigations; it is sufficient here to notice the extreme minuteness of the organisms, necessitating the use of the highest powers of the microscope for their detection. Moreover, as already stated, bacteria are found in large numbers in the bodies of healthy persons, and some of these organisms very closely resemble, if indeed they are not identical with, those that have been found in connection with severe infectious diseases. It is hardly conceivable that minute organisms which abound, for example, in the mouth, and give rise to no changes, should be capable in other parts of causing the most serious symptoms.

In order to prove that a micro-organism is the real cause of a disease, at least three conditions must be fulfilled: In the first place, the same species of micro-organism must be invariably found in the parts affected by the disease in question, at any rate during the early stage, and in no other affection. Secondly, the organism must be cultivated apart from the body in which it has been found, so as to make sure that it has been separated from all other morbid materials to the presence of which the disease might possibly be due. Thirdly, when the organisms thus cultivated have been introduced into the body of an animal capable of being attacked by the disease, similar symptoms ought to be set up, and the same micro-organisms should be found in the newly affected animal. If, in testing any given disease, these conditions are fulfilled, it is scarcely possible to doubt that the micro-organisms are the cause; they certainly can not be the result. It is fair also to argue from diseases in which the conditions are fulfilled, that others in which, owing to circumstances, the tests can not be properly carried out, are due to similar causes.

Very strong evidence is forthcoming in support of the theory that micro-organisms are the cause of infectious diseases. Horned cattle and sheep are subject to a disease termed *anthrax*, or splenic fever, and more than thirty years ago minute, rod-shaped bodies were found in the blood of animals which had died from this disease, which is also communicable to man. The significance of these rods was suspected only after Pasteur's researches into the part played by minute organisms in fermentation. Guided by these discoveries, Davaine inoculated healthy animals with blood from those diseased, with the result of producing similar symptoms, while myriads of organisms were found in

the bodies of those animals which had been inoculated with a very minute quantity of blood. The symptoms are very characteristic, and the disease at one time caused an enormous mortality among cattle in France. By the opponents of the bacterium hypothesis it might, of course, be urged that in the inoculation experiments other morbid materials were simultaneously conveyed, and that the transmission of the disease was due to their presence. To meet this objection, and to fulfill the second condition laid down in the last paragraph, experiments for cultivating the organism were set on foot in the following manner: A drop of blood taken from an animal that had died from anthrax was put into a glass flask containing an infusion of yeast, which had been carefully treated and proved to be free from organisms. In twenty-four hours the liquid, previously clear, was seen to be full of very light flakes, which, when examined under the microscope, were found to be masses of organisms resembling those contained in the blood. A drop taken from this first flask was added to a second and produced the same effect, and a drop from this was added to a third, and so on till a tenth flask was thus charged with organisms. In this way the organism was enormously multiplied and completely freed from the admixture of any other substance. Yet when a drop was taken from the twentieth or even the fiftieth flask of such a series and inserted under the skin of a sheep it caused anthrax or splenic fever, attended by the same symptoms as those produced by the drop of blood taken from the first animal. It is impossible to conceive of any clearer proof that the organism is the sole cause of the disease. So crucial a test, however, can not be applied in every case, for many of the infectious diseases which are the scourge of mankind do not affect the lower animals, and it is therefore impossible to make trial of the organisms found in connection therewith. Besides anthrax, there are other infective diseases in animals which have been proved to be due to bacteria, and these facts strongly support the belief that the infectious diseases of mankind are due to the invasion of similar organisms. It is, however, impossible as yet to dogmatize upon this subject. There have already been too many assertions and inferences drawn therefrom which have turned out to be unwarranted. It is comparatively easy for skilled observers to detect the presence of micro-organisms, and, whenever uniformity of appearance is demonstrable in connection with a given disease, a decided addition has been made to our knowledge. For reasons above given, the next point, viz., the determining whether the organisms are the cause of the disease, is surrounded with great difficulties. The discoveries, however, with regard to splenic fever strongly support the view that bacteria are the efficient agents of contagious diseases.

Space will not permit me to do more than allude to the various theories that have been advanced with regard to the manner in which these tiny organisms produce disease. It was at first thought that they

acted like parasites, and exhausted the system during their development. It is now, however, more commonly believed that the organisms elaborate a special ferment or poison, which, when produced in sufficient amount, gives rise to the symptoms of the disease.

One of the most valuable results of the study of these organisms is the discovery that by cultivation the virulence of some, at least, can be so mitigated that when inoculated they produce only slight and non-fatal symptoms, the development of which in a given animal is nevertheless protective against future attacks of the original disease. By cultivating the organisms of splenic fever at a temperature of 108°, it is found that filaments are produced but not spores, and that by repeated cultivation this growth becomes altered as regards its properties of causing disease. When inoculated it sets up a mild form of splenic fever, not dangerous to life, but perfectly protective against subsequent inoculation with the otherwise poisonous organisms. This discovery is worthy of being classed with that of vaccination as a protection against small-pox.

With regard to the channels through which the contagious organisms are spread, a few words will suffice to state what is known on this point, which is intimately connected with the subject of disinfection. Air and water are the chief media for the propagation of infectious disease. In the case of scarlet fever, which has been taken as the type, the scales detached from the skin and similar tissues from the throat contain the germs of the disease, and these find their way into the atmosphere and are received into the lungs. They attach themselves also to articles of clothing and furniture, and are thus often carried long distances. In the cases of cholera and typhoid fever, the discharges from the patient find their way into water, which thus becomes the channel by which the diseases are propagated. Food, too, may become similarly contaminated. Milk, for instance, has been often known to convey the poisons of typhoid fever, of scarlet fever, and of diphtheria. In the case of the first, the contamination has been probably due to adulterating the milk with foul water containing the disease-germs, but it may have arisen in some cases from the typhoid emanations having been absorbed by the milk. The poisons of scarlet fever and diphtheria were probably transmitted to the milk from the skins and throats of persons employed in the dairy and recently convalescent or scarcely recovered from attacks of these diseases. The germs of certain other infectious diseases find their way into the system through abraded surfaces of the body.

The fatal character of many infectious diseases, and the ease and rapidity with which they spread and attack large masses of the population, are sufficient to account for the endeavors that have been made since very early times to arrest their progress. As in many other matters, practice has preceded science, and, centuries before the vaguest

ideas were entertained as to the nature of the diseases which seemed destined to be the scourges of mankind, efforts were made to stamp them out. As might be expected, many of these efforts were of the rudest description, but the earliest of them aimed at the object which the most modern science also seeks to achieve, viz., the destruction of the contagious material. The term "disinfection" first occurred in literature toward the end of the last century. A French writer, Morveau, in 1801, published a work on "The Disinfection of the Air," but the word was used somewhat earlier by a few English writers.

The most ancient method consisted in destroying by fire everything that had been in contact with the source of infection, the idea, no doubt, being that as fire consumes what is visible, it likewise destroys what is invisible. It is possible that the practice of burning the dead was in a measure based upon the conviction that a source of danger to the living was thus got rid of. The thirteenth chapter of Leviticus contains the most minute directions for disinfecting cases of leprosy; destruction of suspected articles by means of fire, the copious use of water, and isolation of the leper, are the means prescribed. Inspection by the priest was to decide as to the efficacy of these measures. Among the Egyptians and certain Asiatic peoples, the fumigations used by the priests in exorcising disease were probably neither more nor less efficacious than similar processes in vogue at the present day in some European countries.

In the growth of ideas with regard to the causes of infectious diseases, the theory gradually took shape that the infecting matters were formed as a result of the processes of decomposition, and as these processes are generally attended with the development of more or less unpleasant odors, it seemed only natural to assume that the causes of the latter were also the causes of disease. Instead of regarding foul emanations as generally mischievous, the idea was entertained that there was something quite specific about them, and accordingly we find that attempts to mask or neutralize them were regarded as the best methods of checking the spread of infectious diseases. Deodorization came to be considered as equivalent to disinfection. The idea was the more welcome inasmuch as it could be carried into effect without destroying property and without much difficulty. The attempt was certainly in the right direction, for the destruction of noxious agencies was the object in view. Unfortunately, the means employed absolutely failed to effect their purpose, and belief in their efficacy caused very mischievous results, viz., a sense of false security and neglect of ventilation and cleanliness as regards sick persons and surrounding objects. In fact, the confident adoption of deodorants as a means of checking the spread of infectious diseases was a decidedly retrograde step as compared with the use of fire for destruction and of water as a purifying agent.

Chlorine gas was the deodorant which came into very general use

at the beginning of the present century. It was freely employed in hospitals, both civil and military, in prisons, workhouses, etc., and was supposed to be efficacious against fevers, cholera, and small-pox. Whenever its characteristic odor could be perceived, danger of infection was no longer feared. Persons carried about with them small flasks containing chemicals which generated this gas, and inhaled a little when they considered themselves exposed to risk. It soon, however, became evident that these precautions were useless; but even so recently as 1866, during the war between Austria and Prussia, it was thought sufficient to distribute saucers containing chloride of lime throughout the military hospitals, while only feeble efforts were made to insure cleanliness and other important sanitary requirements. In order to act as a real disinfectant, chlorine must be employed in a very different manner. The terrible mortality after surgical operations and severe injuries, a feature of which was that a large majority of patients died with symptoms of blood-poisoning, showed the futility of such attempts at disinfection.

In spite, however, of many similar failures, deodorization has been almost universally regarded as the main object to be accomplished, and other chemical agents have been used in order to combat the gaseous products of decomposition. This object could certainly be attained if the sense of smell were to be the sole judge of success, and the practice of deodorization led also to the discovery and use of many substances which have the power to prevent or retard putrefaction, and were therefore termed antiseptics, and regarded as equivalent to disinfectants. The conclusion, however, was soon forced upon the minds of experimenters that the infective agencies of fevers, small-pox, etc., were neither offensive gases nor the products of putrefaction, but something of an entirely different character. When an infectious disease became associated with the idea of a transportable material which increases and multiplies in its new ground, the discovery was not far off that organisms capable of reproduction are the real causes of the disease.

Definite ideas now prevail as to what is meant by disinfection, and as to the methods by which this object can be attained and the tests whereby their efficacy may be proved. Any substance may be regarded as a true disinfectant which, when added to a quantity of fluid swarming with bacteria, abolishes the reproductive power of these organisms. If the bacteria are capable of producing disease, or the poison of disease, a successful experiment has been made in the way of disinfection. This fact explains the paucity of the real experiences we possess of disinfection proper. Heat, exposure to air and sunlight, and the use of chemical agencies are the means at our disposal; it will be sufficient to point out a few of the methods in which they may be employed.

A very high temperature will, of course, destroy all forms of organized matter, and if we could always isolate the germs of disease and

expose them to great heat, our task would be accomplished. Such isolation is of course impossible, but we make use of heat in the destruction of germs which have found a resting-place in clothes and bedding. The articles are placed in ovens or hot-air chambers, the temperature of which can be raised many degrees above the boiling-point of water. A high temperature, however, has less effect upon the spores than upon the mature organisms, but successive heatings are found to effect the desired result. During their development the spores rapidly pass through several stages, in which they become softened and far more amenable to the action of heat. Exposure to a current of steam at a temperature of 212° is a still more satisfactory method than the use of dry heat. It involves less injury to the articles to be disinfected (a very important point when blankets and other woolen goods have to be dealt with), and it is more simple, more rapid, and more certain in its action. When the necessary appliances are not available, washing the clothes with soap and hot water, and then boiling them for several hours, form an effective substitute. Exposure to sun and air will serve to complete the purification.

For the disinfection of the air of rooms many substances are recommended and employed, but the way in which they are generally used causes them to act merely as deodorants. Even at the present day, the fact is very incompletely realized that ventilation—that is, the continual admission of fresh air—is the only safe method of purifying the atmosphere of rooms containing sources of infection. It is simply useless to place saucers containing chloride of lime, carbolic acid, or Condy's fluid in a contaminated atmosphere with the hope that the germs floating about therein will be caught and killed, like mice in a trap. The chlorine, doubtless, will remove some offensive odors and readily diffuse itself throughout a room, but to act as a true disinfectant it must be so much concentrated that the air in the space containing it would be quite irrespirable by human beings. It is, however, when used scientifically, the best disinfectant we possess for purifying the walls, etc., of an empty room. All the openings should be rendered as nearly air-tight as possible, and the evaporation of a large quantity of water in the room aids the action of the chlorine. It is easily generated by adding hydrochloric acid to bleaching-powder. For deodorizing purposes in sick-rooms and passages, a gas called "euchlorine" will be found very serviceable. It is produced when a few crystals of chlorate of potassium are dropped into a little hydrochloric acid. The mixture can be conveniently made in a small wide-mouthed bottle, which should be placed as near the ceiling as possible, so that the gas may descend into the room. Chlorine and its compounds are much heavier than atmospheric air. Bromide is even more powerful as a disinfectant than chlorine, and both are far superior to sulphurous acid.

Carbolic acid has been much overrated as a disinfectant. The

spores of the micro-organisms discovered in cases of splenic fever have been found to be absolutely unaffected after lying for upward of three months in a five-per-cent solution of carbolic acid in oil. It has been also found that vaccine matter mixed with carbolic acid in solution still retains its efficacy, and the question may therefore well be asked whether the highly diluted carbolic vapor used for purposes of aërial disinfection is not powerless to deal with an atmosphere saturated with the germs of infectious diseases.

When compelled to make use of water of a suspicious class, filtration and boiling constitute the most reliable methods of purification. Spongy iron is upon the whole the most efficacious filtering material. The water, especially if passed through sand afterward, comes out quite clear and pure, and may be kept for a long time without showing any signs of the production of living organisms. Charcoal filters, on the other hand, certainly sometimes allow spores or germs to pass through unchanged, and, when they are employed, boiling should always be superadded. It is not sufficient to bring the water once to the boiling-point; in order to be efficacious, repeated boilings are necessary, for the reasons given in a preceding paragraph. Milk of a suspicious character should always be thus thoroughly boiled. Travelers on the Continent do well to provide themselves with small portable filters, now easily procurable, for in many places the drinking-water is highly charged with impurities. It is satisfactory to know than the tannin contained in tea is a purifying agent of some value as regards organic matter present in water.

It would take up too much space and would be foreign to the purpose I had in view to describe all the methods of using the various disinfectants which are now offered to the public. With regard to many of them it is sufficient to say that their power has been absurdly overestimated. It can not be too strongly insisted upon that deodorization is by no means equivalent to disinfection. My object has been to indicate in the first place what in the present state of our knowledge seems to be the true theory as to the causation of infectious diseases, and to show how obstacles are presented to more rapid scientific progress by the extreme minuteness of the organisms with which we have to deal. With regard to disinfection, I have striven to prove how entirely it must depend for its success on the specific action exercised upon the disease-germs by the means employed. The realization of this necessary relation can not fail to dispel many a fond belief with regard to disinfectants; but it will leave us with a more intelligent and useful appreciation of their true properties, and, by revealing how far we still are from the goal of complete knowledge, may even stimulate the investigator to explore paths of science which are yet unknown. Virgil says, "Felix qui potuit rerum cognoscere causas," and to nothing is this aphorism nowadays more applicable than to a knowledge of those agencies which produce infectious diseases.—*Fortnightly Review.*

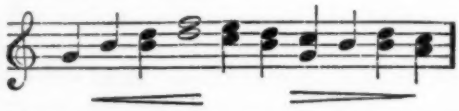
# ON MELODY IN SPEECH.

By F. WEBER.

THERE is an infinite variety of interesting and pleasing sounds in Nature's music around us, that may be noted by an attentive ear; these sounds are mostly melodious and harmonious, or in some harmonious connection, and form exact intervals and chords.

The wind in passing over houses, over trees, in gardens, fields, and forests, produces beautiful sounds of every variety, swelling from the softest to the loudest in majestic grandeur. On a stormy morning in town I heard the wind sing this melody over the roof of the house:

and on a similar night at Boulogne I copied the following passage that was wailing through the house in beautiful *crescendo* and *decrescendo*, and in many repetitions:



Thunder strikes us with awe by its deep, rolling tones; a storm or gale* on land or on the ocean sends forth fierce and sublime sounds, rushing from the lowest to the highest pitch; the stately flow of a great river sings an everlasting deep organ-point, while the lively brook sings melodiously, and modulates like human speech.

The suspended wires of an electric telegraph, when vibrated by a strong wind, produce touching and wailing sounds and chords over a whole country, like so many Æolian harps of sweet and sad sounds that may, from solemn strains and most perfect ideal harmonies, rise in an indescribable and inimitable *crescendo*, higher and higher, to moans and discords, and with the abating wind return to harmony.

All the animals on land, quadrupeds and bipeds, have their characteristic voices and calls in distinct intervals. Of our domestic animals the cow gives a perfect fifth and octave or tenth:

* A *gale* in old Saxon and English means also a song, and with the bold sea-kings of old may also have had this meaning—a song on the ocean. *Gale* in Danish means to "crow": *Hanen galer*, the cock crows. Other relatives, the English to *call* and the German *Kehle*, throat, the organ of song.

The dog barks in a fifth or fourth :

The donkey in coarse voice brays in a perfect octave :

The horse neighs in a descent on the chromatic scale :

The cat in a meek mood cries :

when excited :

and at night on the roof in the garden may howl over an extended compass, and at times give cries like those of an infant.

The hens, geese and ducks in a farmyard chatter in pleasing chorus, and proud chanticleer crows piercing solos between, in the diminished triad and seventh chord :

The birds in bushes and trees, in gardens and woods, sing most beautiful tones in exact intervals, even in melodious chords and in measured time. In passing a garden in the southwest of London on a summer's afternoon, I noted the following tones of different birds in a few minutes :

Animals of the same species vary in their musical gift, as they do in other points. Some animals are very fond of music and greatly affected by it, while others are insensible or quite averse to it; of the former the horse has already in remote antiquity been mentioned for its joy at the sound of the trumpet, as we read in the book of Job (xxxix, 25). Shakespeare also says in his "Merchant of Venice":

> "For do but note a wild and wanton herd,
> Or race of youthful and unhandled colts,
> Fetching mad bounds, bellowing, and neighing loud,
> Which is the hot condition of their blood;
> If they but hear perchance a trumpet sound,
> Or any air of music touch their ears,
> You shall perceive them make a mutual stand,
> Their savage eyes turned to a modest gaze,
> By the sweet power of music."

A touching proof of this old truth was given in the late Franco-German War, when, in the evening after the battle of Gravelotte, on the trumpet-signal for the roll-call of the Life-Guards, more than three hundred riderless horses, some of them wounded and hobbling on three legs, answered the well-known sounds and mustered with the remnant of their regiment.

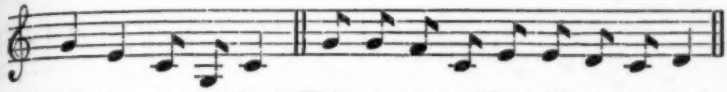
Of the nightingale it is said that in spring the males perch on a tree opposite the hens and sing their best one after another; whereupon the hens select their mates and fly off with them.

The intervals we observe most in the voices of animals are fifths, octaves, and thirds, and also fourths and sixths.

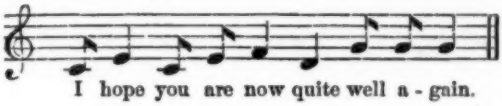
In inanimate sounding bodies, as in church-bells, in the larger strings of the piano, in the Æolian harp (or wind-harp), the fifth and tenth (or third in the next higher octave), commonly called *harmonics*, are very distinctly heard toward the end of the principal sound.

The *human voice* in speaking uses also these intervals foremost, but it moves also over most of the other intervals in melodious and harmonious combinations. We speak in melodies and harmonies, improvising them by the impulse of our thoughts and feelings over an extent or compass of one and a half to two octaves; as every plant grows with a certain color, so every sentence is spoken in some melody which rises in sympathy with the sense and sentiment of the words, giving character to the whole sentence; and from the quality and accent of this musical investment, the truth and sincerity of the words may be felt, and the character of the speaker be traced.

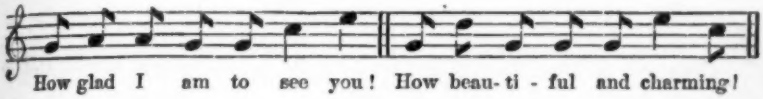
Sentences are spoken in a certain musical key, and are mostly begun on the fifth or dominant of the scale of the key-note, from which they descend in seconds or thirds or other intervals to the key-note, and, may be, down to the lower dominant:



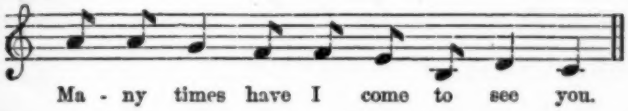

Or they begin on the key-note and move to the dominant :

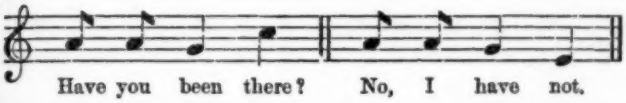



Or they ascend from the dominant to the octave, and to the ninth and tenth :

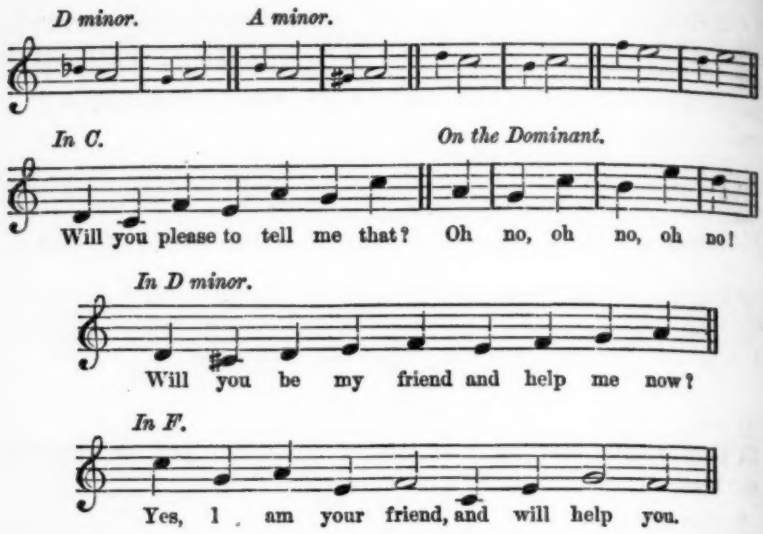



Many expressions are begun on the sixth as on a leading tone to the dominant :

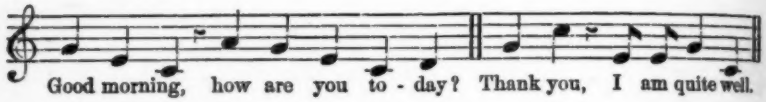


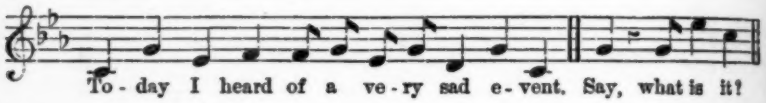

The voice moves mostly up and down in the principal scale and chord, and in their relative harmonies, and frequently dwells on introducing tones from above or below to a tone of any of these chords :


D minor.
A minor.
In C.
On the Dominant.
Will you please to tell me that? Oh no, oh no, oh no!
In D minor.
Will you be my friend and help me now?
In F.
Yes, I am your friend, and will help you.

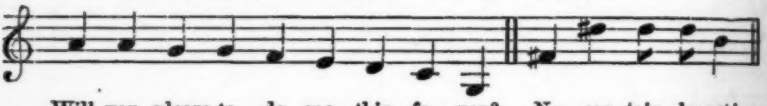
Common conversation is generally held in the major mode, and in the same key:




But when sad and pathetic it is in minor:

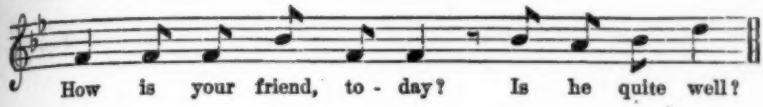


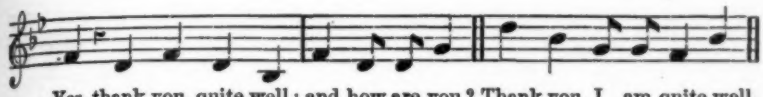

An unfriendly reply is mostly in an unrelated key:

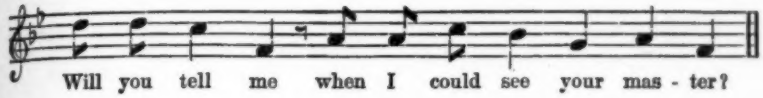


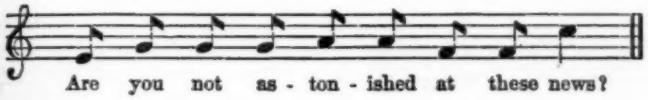

Every person has his own fundamental and favorite key in which he generally speaks, but which he often transposes higher or lower in sympathy to other voices, and when he is excited. In divine service at church I have heard the minister begin in his natural key, and the choir sing the response in a higher key; when the minister, possessing a musical ear, gradually rose to the tone of the choir. In one instance the minister began the communion service in E flat, and the choir and organ gave the response in F. The minister gradually raised his voice, and by the fourth commandment met the tone of the choir, wherein he continued to the end.

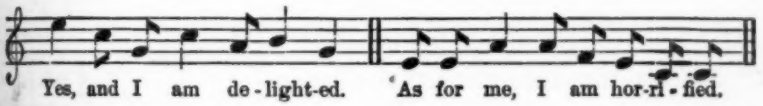
In ordinary conversation the different voices speak in the key of B flat, B, or C, persons with soprano or tenor voices moving in the upper part of the scale, and the alto and bass voices holding to the lower part of the same, and the replies turning often to the dominant or subdominant:

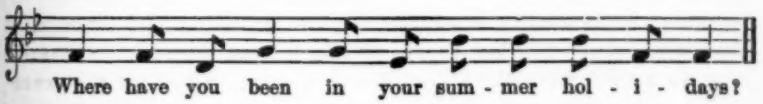


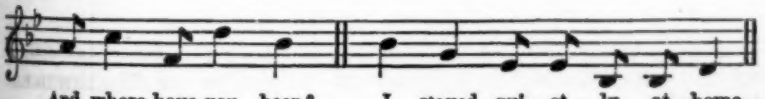





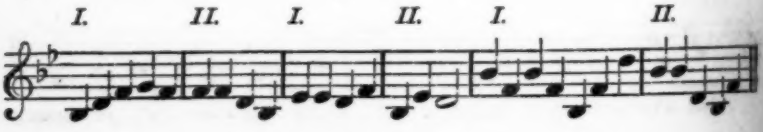





Conversation in a railway-train, of father, mother, and two daughters:

In a recent journey from Calais to Boulogne, Amiens, and Rheims, I found most people there speak in the key of B flat major and minor. The large bells at the belfry at Boulogne and at the cathedral at Rheims also have the low B flat, and may have been cast in that tone to be in unison with the voice of the people. Some of the conversations along the route, and the calling out of the names of railway-stations, were as follow:

Two women on Boulogne pier.



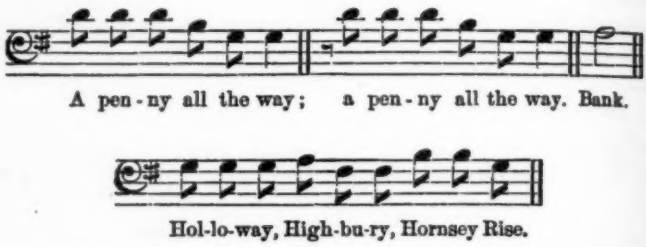
At the fish-market at Boulogne:

At Calais.

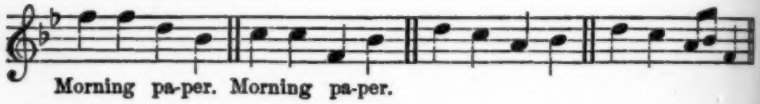
Neufchâtel, Neufchâtel.
Verton, Verton, Couchelle le temple.
Verton. Abbeville. Montez en voiture. St. Erme. Varsigny. La Fère. Tergnier. Amiens.
Martellan. Villiers Bretonneux. St. Josse. Dannes Camiers. Rixant, Rixant, Rixant.

The French railway guards and conductors deserve to be complimented for their melodious calls of the names of the stations.

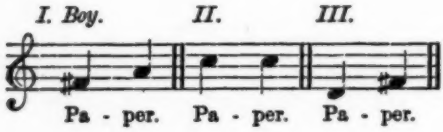
The omnibus conductors in London ordinarily call out in the key of B flat; but at busy places and hours they speak in a higher key. At Charing Cross I heard them call:




The paper boys call:




The calls of three paper boys I heard on one day at Charing Cross formed the dominant seventh chord:




Some of the cries of venders in the streets are quite beautiful and touching, like the following I heard and noted down of a boy in Long Acre:

Of a man at Boulogne :

A collection of such melodious and pleasant cries from towns in England and abroad would be most interesting in showing the musical talent and taste of the people who invent and use them.

Friendly conversations keep mostly to the key of the principal person of the circle, who at the time gives, not only the moral and social tone, but also the musical tone to all around him ; and if any one of the company would speak in a different tone, he would be out of tune and out of countenance with the others. When we read by ourselves we speak in C, or in B flat, or lower still ; but when we read to others, we raise our voice to the fourth or fifth of our own key, that is, to G, or F, or E flat.

We ought to study and exercise our voice in the different keys in which we may have to speak, through the whole extent of our voice, to enrich it with an easy flow of a variety of tones, so as to match our words and sentences with suitable melodious turns, to render them fervid and impressive, to touch a vibrating chord of sympathy and interest in our hearers.

When abroad I heard once a young orator speaking for nearly half an hour, with every sentence descending in these off tones of the scale which unvarying descent of 6 5 4 3 2 1 made his well-worded speech tedious and unimpressive.

In a speech of some length the orator will save his voice by keeping more in the middle part of it, on and about his individual dominant, which part requires least strain and is the most pleasing ; from where he may with good effect rise or descend in accordance with the exciting or soothing flow of his ideas and sentiments. By thus arranging the melodious part of his speech somewhat like a musical composition, and suitably contrasting the high parts of his voice with the middle and lower parts, he will engage and rivet his audience all the more to every word.

Some persons spoil the sonorousness of their voice by not letting it flow out freely and naturally, by giving it a peculiar throaty twang, by speaking too high, or by using the head voice (falsetto) too much.

The natural voice, free from the chest, is most agreeable and effective in conversation and in addressing an audience; it is least fatiguing to the speaker and to the hearer, and penetrates farthest.

Spirited and impressive sermons, mostly in a major key, modulate in elevating ideas to the dominant, in soothing sentiments to the subdominant and the relative minor keys, but return and end in the principal key like a musical composition.

Collections of melodies in sermons and speeches of different nations would be most interesting and useful to students in oratory, be it for a dignified and becoming rendering of the great truths and sentiments in religion and humanity, or for persuasion, admonition, and encouragement in secular matters.

The following melodies I have copied from a speech by an Oxford professor, and from a sermon by an English bishop.

From an English speech (by an Oxford professor):

From (the sermon of an English bishop) an English sermon:

—*Longman's Magazine.*

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PROFESSOR NEUMAYER, of Hamburg, urges the necessity of Antarctic exploration, laying special stress on its importance for geology and paleontology. He anticipates that it will show that the south pole was a center of dispersion of animals and plants for the southern hemisphere, as the north pole is believed to have been for the northern.

# SCIENTIFIC AND PSEUDO-SCIENTIFIC REALISM.

By Professor T. H. HUXLEY.

NEXT to undue precipitation in anticipating the results of pending investigations, the intellectual sin which is commonest and most hurtful to those who devote themselves to the increase of knowledge is the omission to profit by the experience of their predecessors recorded in the history of science and philosophy. It is true that, at the present day, there is more excuse than at any former time for such neglect. No small labor is needed to raise ones' self to the level of the acquisitions already made; and able men who have achieved thus much know that, if they devote themselves body and soul to the increase of their store, and avoid looking back with as much care as if the injunction laid on Lot and his family were binding upon them, such devotion is sure to be richly repaid by the joys of the discoverer and the solace of fame, if not by rewards of a less elevated character.

So, following the advice of Francis Bacon, we refuse *inter mortuos quærere vivum* (to seek what is living among the dead); we leave the past to bury its dead, and ignore our intellectual ancestry. Nor are we content with that. We follow the evil example set us, not only by Bacon, but by almost all the men of the Renaissance, in pouring scorn upon the work of our immediate spiritual forefathers, the school-men of the middle ages. It is accepted as a truth which is indisputable that, for seven or eight centuries, a long succession of able men—some of them of transcendent acuteness and encyclopedic knowledge—devoted laborious lives to the grave discussion of mere frivolities and the arduous pursuit of intellectual Will-o'-the-wisps. To say nothing of a little modesty, a little impartial pondering over personal experience might suggest a doubt as to the adequacy of this short and easy method of dealing with a large chapter of the history of the human mind. Even an acquaintance with popular literature which had extended so far as to include that part of the contributions of Sam Slick which contains his weighty aphorism that "there is a great deal of human nature in all mankind," might raise a doubt whether, after all, the men of that epoch, who, take them all round, were endowed with wisdom and folly in much the same proportion as ourselves, were likely to display nothing better than the qualities of energetic idiots, when they devoted their faculties to the elucidation of problems which were to them, and indeed are to us, the most serious which life has to offer. Speaking for myself, the longer I live the more I am disposed to think that there is much less either of pure folly or of pure wickedness in the world than is commonly supposed. It may be doubted if any sane man ever said to himself, "Evil, be thou my good," and I have never yet had the good

fortune to meet with a perfect fool. When I have brought to the inquiry the patience and long-suffering which become a scientific investigator, the most promising specimens have turned out to have a good deal to say for themselves from their own point of view. And, sometimes, calm reflection has taught the humiliating lesson that their point of view was not so different from my own as I had fondly imagined. Comprehension is more than half-way to sympathy, here as elsewhere.

If we turn our attention to scholastic philosophy in the frame of mind suggested by these prefatory remarks, it assumes a very different character from that which it bears in general estimation. No doubt it is surrounded by a dense thicket of thorny logomachies and obscured by the dust-clouds of a barbarous and perplexing terminology. But suppose that, undeterred by much grime and by many scratches, the explorer has toiled through this jungle, he comes to an open country which is amazingly like his dear native land. The hills which he has to climb, the ravines he has to avoid, look very much the same; there is the same infinite space above, and the same abyss of the unknown below; the means of traveling are the same, and the goal is the same.

That goal for the school-men, as for us, is the settlement of the question how far the universe is the manifestation of a rational order; in other words, how far logical deduction from indisputable premises will account for that which has happened and does happen. That was the object of scholasticism, and, so far as I am aware, the object of modern science may be expressed in the same terms. In pursuit of this end, modern science takes into account all the phenomena of the universe which are brought to our knowledge by observation or by experiment. It admits that there are two worlds to be considered, the one physical and the other psychical, and that though there is a most intimate relation and interconnection between the two, the bridge from one to the other has yet to be found; that their phenomena run, not in one series, but along two parallel lines.

To the school-men the duality of the universe appeared under a different aspect. How this came about will not be intelligible unless we clearly apprehend the fact that they did really believe in dogmatic Christianity, as it was formulated by the Roman Church. They did not give a mere dull assent to anything the Church told them on Sundays, and ignore her teachings for the rest of the week; but they lived and moved and had their being in that supersensible theological world which was created, or rather grew up, during the first four centuries of our reckoning, and which occupied their thoughts far more than the sensible world in which their earthly lot was cast.

For the most part, we learn history from the colorless compendiums or partisan briefs of mere scholars, who have too little acquaintance with practical life, and too little insight into speculative problems, to

understand that about which they write. In historical science, as in all sciences which have to do with concrete phenomena, laboratory practice is indispensable, and the laboratory practice of historical science is afforded, on the one hand, by active social and political life, and, on the other, by the study of those tendencies and operations of the mind which embody themselves in philosophical and theological systems. Thucydides and Tacitus, and, to come nearer our own time, Hume and Grote, were men of affairs, and had acquired, by direct contact with social and political history in the making, the secret of understanding how such history is made. Our notions of the intellectual history of the middle ages are, unfortunately, too often derived from writers who have never seriously grappled with philosophical and theological problems: and hence that strange myth of a millennium of moonshine to which I have adverted.

However, no very profound study of the works of contemporary writers who, without devoting themselves specially to theology or philosophy, were learned and enlightened—such men, for example, as Eginhard or Dante—is necessary to convince one's self that, for them, the world of the theologian was an ever-present and awful reality. From the center of that world, the Divine Trinity, surrounded by a hierarchy of angels and saints, contemplated and governed the insignificant sensible world in which the inferior spirits of men, burdened with the debasement of their material embodiment and continually solicited to their perdition by a no less numerous and almost as powerful hierarchy of devils, were constantly struggling on the edge of the pit of everlasting damnation.*

The men of the middle ages believed that through the Scriptures, the traditions of the fathers, and the authority of the Church, they

* There is no exaggeration in this brief and summary view of the Catholic cosmos. But it would be unfair to leave it be supposed that the Reformation made any essential alteration, except perhaps for the worse, in that cosmology which called itself "Christian." The protagonist of the Reformation, from whom the whole of the Evangelical sects are lineally descended, states the case with that plainness of speech, not to say brutality, which characterized him. Luther says that man is a beast of burden who only moves as his rider orders; sometimes God rides him, and sometimes Satan. "Sic voluntas humana in medio posita est, ceu jumentum; si insederit Deus, vult et vadit, quo vult Deus. . . . Si insederit Satan, vult et vadit, quo vult Satan; nec est in ejus arbitrio ad utrum sessorem currere, aut eum quærere, sed ipsi sessores certant ob ipsum obtinendum et possidendum" (Thus the human will is put in the middle, like a beast of burden; if God sits upon it, it wills and goes where God wills; . . . if Satan sits upon it, it wills and goes where Satan wills. Nor is it within its discretion to run to either rider or to seek after him, but the riders themselves contend which shall get and possess it).—(*De Servo Arbitrio*, M. Lutheri Opera, edition 1546, tomus ii, p. 468.) One may hear substantially the same doctrine preached in the parks and at street-corners by zealous volunteer missionaries of Evangelicism any Sunday in modern London. Why these doctrines, which are conspicuous by their absence in the four Gospels, should arrogate to themselves the title of Evangelical, in contradistinction to Catholic, Christianity, may well perplex the impartial inquirer, who, if he were obliged to choose between the two, might naturally prefer that which leaves the poor beast of burden a little freedom of choice.

were in possession of far more, and more trustworthy, information with respect to the nature and order of things in the theological world than they had in regard to the nature and order of things in the sensible world. And, if the two sources of information came into conflict, so much the worse for the sensible world, which, after all, was more or less under the dominion of Satan. Let us suppose that a telescope powerful enough to show us what is going on in the nebula of the sword of Orion, should reveal a world in which stones fell upward, parallel lines met, and the fourth dimensions of space was quite obvious. Men of science would have only two alternatives before them. Either the terrestrial and the nebular facts must be brought into harmony by such feats of subtile sophistry as the human mind is always capable of performing when driven into a corner, or Science must throw down its arms in despair, and commit suicide either by the admission that the universe is, after all, irrational, inasmuch as that which is truth in one corner of it is absurdity in another, or by a declaration of incompetency.

In the middle ages, the labors of those great men who endeavored to reconcile the system of thought which started from the data of pure reason with that which started from the data of Roman theology produced the system of thought which is known as scholastic philosophy; the alternative of surrender and suicide is exemplified by Avicenna and his followers when they declared that that which is true in theology may be false in philosophy, and *vice versa;* and by Sanchez in his famous defense of the thesis "*Quod nil scitur*" (That nothing is known).

To those who deny the validity of one of the primary assumptions of the disputants—who decline, on the ground of the utter insufficiency of the evidence, to put faith in the reality of that other world, the geography and the inhabitants of which are so confidently described in the so-called * Christianity of Catholicism—the long and bitter contest which engaged the best intellects for so many centuries may seem a terrible illustration of the wasteful way in which the struggle for existence is carried on in the world of thought, no less than in that of matter. But there is a more cheerful mode of looking at the history of scholasticism. It ground and sharpened the dialectic implements of our race as perhaps nothing but discussions, in the result of which men thought their eternal no less than their temporal interests were at stake, could have done. When a logical blunder may insure combustion, not only in the next world but in this, the construction of syllogisms acquires a peculiar interest. Moreover, the schools kept the thinking faculty alive and active, when the disturbed state of civil life, the mephitic atmosphere engendered by the dominant ecclesiasticism, and

* I say "so-called," not by way of offense, but as a protest against the monstrous assumption that Catholic Christianity is explicitly or implicitly contained in any trustworthy record of the teaching of Jesus of Nazareth.

the almost total neglect of natural knowledge, might well have stifled it. And, finally, it should be remembered that scholasticism really did thrash out pretty effectually certain problems which have presented themselves to mankind ever since they began to think, and which, I suppose, will present themselves so long as they continue to think. Consider, for example, the controversy of the Realists and the Nominalists, which was carried on with varying fortunes, and under various names, from the time of Scotus Erigena to the end of the scholastic period. Has it now a merely antiquarian interest? Has Nominalism, in any of its modifications, so completely won the day that Realism may be regarded as dead and buried without hope of resurrection? Many people seem to think so, but it appears to me that, without taking Catholic philosophy into consideration, one has not to look about far to find evidence that Realism is still to the fore, and indeed extremely lively.*

The other day I happened to meet with a report of a sermon recently preached in St. Paul's Cathedral. From internal evidence I am inclined to think that the report is substantially correct. But, as I have not the slightest intention of finding fault with the eminent theologian and eloquent preacher to whom the discourse is attributed, for employment of scientific language in a manner for which he could find only too many scientific precedents, the accuracy of the report in detail is not to the purpose. I may safely take it as the embodiment of views which are thought to be quite in accordance with science by many excellent, instructed, and intelligent people:

> The preacher further contended that it was yet more difficult to realize that our earthly home would become the scene of a vast physical catastrophe. Imagination recoils from the idea that the course of Nature—the phrase helps to disguise the truth—so unvarying and regular, the ordered sequence of movement and life, should suddenly cease. Imagination looks more reasonable when it assumes the air of scientific reason. Physical law, it says, will prevent the occurrence of catastrophes only anticipated by an apostle in an unscientific age. Might not there, however, be a suspension of a lower law by the intervention of a higher? Thus, every time we lifted our arms we defied the laws of gravitation, and in railways and steamboats powerful laws were held in check by others. The Flood and the destruction of Sodom and Gomorrah were brought about by the operations of existing laws, and may it not be that in His illimitable universe there are more important laws than those which surround our puny life—moral and not merely physical forces? Is it inconceivable that the day will

* It may be desirable to observe that, in modern times, the term "Realism" has acquired a signification wholly different from that which attached to it in the middle ages. We commonly use it as the contrary of Idealism. The Idealist holds that the phenomenal world has only a subjective existence, the Realist that it has an objective existence. I am not aware that any mediæval philosopher was an Idealist in the sense in which we apply the term to Berkeley. In fact, the cardinal defect of their speculations lies in their oversight of the considerations which lead to Idealism. If many of them regarded the material world as a negation, it was an active negation; not zero, but a minus quantity.

come when these royal and ultimate laws shall wreck the natural order of things which seems so stable and so fair? Earthquakes were not things of remote antiquity, as an island off Italy, the Eastern Archipelago, Greece, and Charleston bore witness. . . . In presence of a great earthquake men feel how powerless they are, and their very knowledge adds to their weakness. The end of human probation, the final dissolution of organized society, and the destruction of man's home on the surface of the globe, were none of them violently contrary to our present experience, but only the extension of present facts. The presentiment of death was common; there were felt to be many things which threatened the existence of society; and, as our globe was a ball of fire, at any moment the pent-up forces which surge and boil beneath our feet might be poured out.—*Pall Mall Gazette, December* 6, 1886.

The preacher appears to entertain the notion that the occurrence of a "catastrophe"* involves a breach of the present order of Nature—that it is an event incompatible with the physical laws which at present obtain. He seems to be of opinion that "scientific reason" lends its authority to the imaginative supposition that physical law will prevent the occurrence of the "catastrophes" anticipated by an unscientific apostle.

Scientific reason, like Homer, sometimes nods; but I am not aware that it has ever dreamed dreams of this sort. The fundamental axiom of scientific thought is that there is not, never has been, and never will be, any disorder in Nature. The admission of the occurrence of any event which was not the logical consequence of the immediately antecedent events, according to these definite ascertained, or unascertained, rules which we call the "laws of Nature," would be an act of self-destruction on the part of Science.

"Catastrophe" is a relative conception. For ourselves it means an event which brings about very terrible consequences to man, or impresses his mind by its magnitude relatively to him. But events which are quite in the natural order of things to us, may be frightful catastrophes to other sentient beings. Surely no interruption of the order of Nature is involved if, in the course of descending through an Alpine pine-wood, I jump upon an ant-hill and in a moment wreck a whole city and destroy a hundred thousand of its inhabitants. To the ants, the catastrophe is worse than the earthquake of Lisbon. To me, it is the natural and necessary consequence of the laws of matter in motion. A redistribution of energy has taken place, which is perfectly in accordance with natural order, however unpleasant its effects may be to the ants.

Imagination, inspired by scientific reason, and not merely assuming the airs thereof, as it unfortunately too often does in the pulpit, so far from having any right to repudiate catastrophes and deny the possi-

* At any rate, a catastrophe greater than the Flood, which, as I observe with interest, is as calmly assumed by the preacher to be an historical event as if Science had never had a word to say on that subject!

bility of the cessation of motion and life, easily finds justification for the exactly contrary course. Kant, in his famous "Theory of the Heavens," declares the end of the world and its reduction to a formless condition to be a necessary consequence of the causes to which it owes its origin and continuance. And, as to catastrophes of prodigious magnitude and frequent occurrence, they were the favorite *asylum ignorantiæ* (asylum of ignorance) of geologists not a quarter of a century ago. If modern geology is becoming more and more disinclined to call in catastrophes to its aid, it is not because of any *a priori* difficulty in reconciling the occurrence of such events with the universality of order, but because the *a posteriori* evidence of the occurrence of events of this character in past times has more or less completely broken down.

It is, to say the least, highly probable that this earth is a mass of extremely hot matter, invested by a cooled crust, through which the hot interior still continues to cool, though with extreme slowness. It is no less probable that the faults and dislocations, the foldings and fractures, everywhere visible in the stratified crust, its large and slow movements through miles of elevation and depression, and its small and rapid movements which give rise to the innumerable perceived and unperceived earthquakes which are constantly occurring, are due to the shrinkage of the crust on its cooling and contracting nucleus.

Without going beyond the range of fair scientific analogy, conditions are easily conceivable which should render the loss of heat far more rapid than it is at present; and such an occurrence would be just as much in accordance with ascertained laws of Nature as the more rapid cooling of a red-hot bar, when it is thrust into cold water, than when it remains in the air. But much more rapid cooling might entail a shifting and rearrangement of the parts of the crust of the earth on a scale of unprecedented magnitude, and bring about "catastrophes" to which the earthquake of Lisbon is but a trifle. It is conceivable that man and his works and all the higher forms of animal life should be utterly destroyed; that mountain-regions should be converted into ocean-depths and the floor of oceans raised into mountains; and the earth become a scene of horror which even the lurid fancy of the writer of the Apocalypse would fail to portray. And yet, to the eye of Science, there would be no more disorder here than in the sabbatical peace of a summer sea. Not a link in the chain of natural causes and effects would be broken, nowhere would there be the slightest indication of the "suspension of a lower law by a higher." If a sober scientific thinker is inclined to put little faith in the wild vaticinations of universal ruin which, in a less saintly person than the seer of Patmos, might seem to be dictated by the fury of a revengeful fanatic, rather than by the spirit of Him who bid men love their enemies, it is not on the ground that they contradict scientific principles, but because the evidence of their scientific value does not fulfill

the conditions on which weight is attached to evidence. The imagination which supposes that it does, simply does not "assume the air of scientific reason."

I repeat that, if imagination is used within the limits laid down by science, disorder is unimaginable. If a being endowed with perfect intellectual and æsthetic faculties, but devoid of the capacity for suffering pain, either physical or moral, were to devote his utmost powers to the investigation of Nature, the universe would seem to him to be a sort of kaleidoscope, in which, at every successive moment of time, a new arrangement of parts of exquisite beauty and symmetry would present itself; and each of them would show itself to be the logical consequence of the preceding arrangement, under the conditions which we call the laws of Nature. Such a spectator might well be filled with that *Amor intellectualis Dei* (intellectual love of God), the beatific vision of the *vita contemplativa* (contemplative life), which some of the greatest thinkers of all ages, Aristotle, Aquinas, Spinoza, have regarded as the only conceivable eternal felicity; and the vision of illimitable suffering, as if sensitive beings were unregarded animalcules which had got between the bits of glass of the kaleidoscope, which mars the prospect to us poor mortals, in no wise alters the fact that order is lord of all, and disorder only a name for that part of the order which gives us pain.

The other fallacious employment of the names of scientific conceptions which pervades the preacher's utterance, brings me back to the proper topic of the present paper. It is the use of the word "law" as if it denoted a thing—as if a "law of Nature," as Science understands it, were a being endowed with certain powers, in virtue of which the phenomena expressed by that law are brought about. The preacher asks, "Might not there be a suspension of a lower law by the intervention of a higher?" He tells us that every time we lift our arms we defy the law of gravitation. He asks whether some day certain "royal and ultimate laws" may not come and "wreck" those laws which are at present, it would appear, acting as Nature's police. It is evident, from these expressions, that "laws," in the mind of the preacher, are entities having an objective existence in a graduated hierarchy. And it would appear that the "royal laws" are by no means to be regarded as constitutional royalties: at any moment, they may, like Eastern despots, descend in wrath among the middle-class and plebeian laws, which have hitherto done the drudgery of the world's work, and—to use phraseology not unknown in our seats of learning—"make hay" of their belongings. Or perhaps a still more familiar analogy has suggested this singular theory; and it is thought that high laws may "suspend" low laws, as a bishop may suspend a curate.

Far be it from me to controvert these views, if any one likes to hold them. All I wish to remark is that such a conception of the nature of "laws" has nothing to do with modern science. It is scho-

lastic realism—realism as intense and unmitigated as that of Scotus Erigena a thousand years ago. The essence of such realism is that it maintains the objective existence of universals, or, as we call them nowadays, general propositions. It affirms, for example, that "man" is a real thing, apart from individual men, having its existence, not in the sensible but in the intelligible world, and clothing itself with the accidents of sense to make the Jack and Tom and Harry whom we know. Strange as such a notion may appear to modern scientific thought, it really pervades ordinary language. There are few people who would, at once, hesitate to admit that color, for example, exists apart from the mind which conceives the idea of color. They hold it to be something which resides in the colored object; and so far they are as much realists as if they had sat at Plato's feet. Reflection on the facts of the case must, I imagine, convince every one that "color" is—not a mere name, which was the extreme Nominalist position—but a name for that group of states of feeling which we call blue, red, yellow, and so on, and which we believe to be caused by luminiferous vibrations which have not the slightest resemblance to color; while these, again, are set afoot by states of the body to which we ascribe color, but which are equally devoid of likeness to color.

In the same way, a law of Nature, in the scientific sense, is the product of a mental operation upon the facts of Nature which come under our observation, and has no more existence outside the mind than color has. The law of gravitation is a statement of the manner in which experience shows that bodies, which are free to move, do, in fact, move toward another. But the other facts of observation, that bodies are not always moving in this fashion, and sometimes move in a contrary direction, are implied in the words "free to move." If it is a law of Nature that bodies tend to move toward one another in a certain way, it is another and no less true law of Nature that, if bodies are not free to move as they tend to do, either in consequence of an obstacle or of a contrary impulse from some other source of energy than that to which we give the name of gravitation, they either stop still or go another way.

Scientifically speaking, it is the acme of absurdity to talk of a man defying the law of gravitation when he lifts his arm. The general store of energy in the universe working through terrestrial matter is doubtless tending to bring the man's arm down; but the particular fraction of that energy which is working through certain of his nervous and muscular organs is tending to drive it up, and, more energy being expended on the arm in the upward than in the downward direction, the arm goes up accordingly. But the law of gravitation is no more defied in this case than when a grocer throws so much sugar into the empty pan of his scales that the weighted one kicks the beam.

The tenacity of the wonderful fallacy that the laws of Nature are agents instead of being, as they really are, a mere record of experience,

upon which we base our interpretations of that which does happen, and our anticipation of that which will happen, is an interesting psychological fact, and would be unintelligible if the tendency of the human mind toward realism were less strong.

Even at the present day, and in the writings of men who would at once repudiate scholastic realism in any form, "law" is often inadvertently employed in the sense of cause, just as, in common life, a man will say that he is compelled by the law to do so and so, when, in point of fact, all he means is that the law orders him to do it, and tells him what will happen if he does not do it. We commonly hear of bodies falling to the ground by reason of the law of gravitation, whereas that law is simply the record of the fact that, according to all experience, they have so fallen (when free to move), and of the grounds of a reasonable expectation that they will so fall. If it should be worth anybody's while to seek for examples of such misuse of language on my own part, I am not at all sure he might not succeed, though I have usually been on my guard against such looseness of expression. If I am guilty, I do penance beforehand, and only hope that I may thereby deter others from committing the like fault. And I venture on this personal observation by way of showing that I have no wish to bear hardly on the preacher for falling into an error for which he might find good precedents. But it is one of those errors which, in the case of a person engaged in scientific pursuits, does little harm, because it is corrected as soon as its consequences become obvious; while those who know physical science only by name are, as has been seen, easily led to build a mighty fabric of unrealities on this fundamental fallacy. In fact, the habitual use of the word "law," in the sense of an active thing, is almost a mark of pseudo-science; it characterizes the writings of those who have appropriated the forms of science without knowing anything of its substance.

There are two classes of these people: those who are ready to believe in any miracle so long as it is guaranteed by ecclesiastical authority, and those who are ready to believe in any miracle so long as it has some different guarantee. The believers in what are ordinarily called miracles—those who accept the miraculous narratives which they are taught to think are essential elements of religious doctrine—are in the one category; the spirit-rappers, table-turners, and all the other devotees of the occult sciences of our day are in the other; and, if they disagree in most things, they agree in this, namely, that they ascribe to science a dictum that is not scientific; and that they endeavor to upset the dictum thus foisted on science by a realistic argument which is equally unscientific.

It is asserted, for example, that, on a particular occasion, water was turned into wine; and, on the other hand, it is asserted that a man or a woman "levitated" to the ceiling, floated about there, and finally sailed out by the window. And it is assumed that the pardonable

skepticism, with which most scientific men receive these statements, is due to the fact that they feel themselves justified in denying the possibility of any such metamorphosis of water or of any such levitation, because such events are contrary to the laws of Nature. So the question of the preacher is triumphantly put: How do you know that there are not "higher" laws of Nature than your chemical and physical laws, and that these higher laws may not intervene and "wreck" the latter?

The plain answer to this question is, Why should anybody be called upon to say how he knows that which he does not know? You are assuming that laws are agents—efficient causes of that which happens—and that one law can interfere with another. To us that assumption is as nonsensical as if you were to talk of a proposition of Euclid being the cause of the diagram which illustrates it, or of the integral calculus interfering with the rule of three. Your question really implies that we pretend to complete knowledge not only of all past and present phenomena, but of all that are possible in the future, and we leave all that sort of thing to the adepts of esoteric Buddhism. Our pretensions are infinitely more modest. We have succeeded in finding out the rules of action of a little bit of the universe; we call these rules "laws of Nature," not because anybody knows whether they bind Nature or not, but because we find it is obligatory on us to take them into account, both as actors under Nature, and as interpreters of Nature. We have any quantity of genuine miracles of our own, and, if you will furnish us with as good evidence of your miracles as we have of ours, we shall be quite happy to accept them and to amend our expression of the laws of Nature in accordance with the new facts.

As to the particular cases adduced, we are so perfectly fair-minded as to be willing to help your case as far as we can. You are quite mistaken in supposing that anybody who is acquainted with the possibilities of physical science will undertake categorically to deny that water may be turned into wine. Many very competent judges are already inclined to think that the bodies, which we have hitherto called elementary, are really composite arrangements of the particles of a uniform primitive matter. Supposing that view to be correct, there would be no more theoretical difficulty about turning water into alcohol, ethereal and coloring matters, than there is at this present moment any practical difficulty in working other such miracles; as when we turn sugar into alcohol, carbonic acid, glycerine, and succinic acid; or transmute gas-refuse into perfumes rarer than musk, and dyes richer than Tyrian purple. If the so-called "elements," oxygen and hydrogen, which compose water, are aggregates of the same ultimate particles or physical units, as those which enter into the structure of the so-called element "carbon," it is obvious that alcohol and other substances—composed of carbon, hydrogen, and oxygen—may be produced by a rearrangement of some of the units of oxygen and hydro-

gen into the "element" carbon, and their synthesis with the rest of the oxygen and hydrogen.

Theoretically, therefore, we can have no sort of objection to your miracle. And our reply to the levitators is just the same: Why should not your friend "levitate"? Fish are said to rise and sink in the water by altering the volume of an internal air-receptacle, and there may be many ways Science, as yet, knows nothing of, by which we who live at the bottom of an ocean of air may do the same thing. Dialectic gas and wind appear to be by no means wanting among you, and why should not long practice in pneumatic philosophy have resulted in the internal generation of something a thousand times rarer than hydrogen, by which, in accordance with the most ordinary natural laws, you would not only rise to the ceiling and float there in *quasi*-angelic posture, but perhaps, as one of your feminine adepts is said to have done, flit swifter than train or telegram to "still-vexed Bermoothes," and twit Ariel, if he happens to be there, for a sluggard? We have not the presumption to deny the possibility of anything you affirm—only, as our brethren are particular about evidence, do give us as much to go upon as may save us from being roared down by their inextinguishable laughter.

Enough of the realism which clings about "laws." There are plenty of other exemplifications of its vitality in modern science, but I will cite only one of them.

This is the conception of "vital force" which comes straight from the philosophy of Aristotle. It is a fundamental proposition of that philosophy that a natural object is composed of two constituents—the one its matter, conceived as inert or even, to a certain extent, opposed to orderly and purposive motion; the other its form, conceived as a *quasi*-spiritual something, containing or conditioning the actual activities of the body and the potentiality of its possible activities.

I am disposed to think that the prominence of this conception in Aristotle's theory of things arose from the circumstance that he was, to begin with and throughout his life, devoted to biological studies. In fact, it is a notion which must force itself upon the mind of any one who studies biological phenomena, without reference to general physics as they now stand. Everybody who observes the obvious phenomena of the development of a seed into a tree, or of an egg into an animal, will note that a relatively formless mass of matter gradually grows, takes a definite shape and structure, and finally begins to perform actions which contribute toward a certain end, namely, the maintenance of the individual in the first place, and of the species in the second. Starting from the axiom that every event has a cause, we have here the *causa finalis* (final cause) manifested in the last set of phenomena, the *causa materialis* (material cause) and *formalis* (formal) in the first, while the existence of a *causa efficiens* (efficient cause) within the seed or egg and its product, is a corollary from the phe-

nomena of growth and metamorphosis, which proceed in unbroken succession and make up the life of the animal or plant.

Thus, at starting, the egg or seed is matter having a "form" like all other material bodies. But this form has the peculiarity, in contradistinction to lower substantial "forms," that it is a power which constantly works toward an end by means of living organization.

So far as I know, Liebnitz is the only philosopher (at the same time a man of science, in the modern sense, of the first rank) who has noted that the modern conception of Force, as a sort of atmosphere enveloping the particles of bodies, and having potential or actual activity, is simply a new name for the Aristotelian Form.* In modern biology, up till within quite recent times, the Aristotelian conception held undisputed sway; living matter was endowed with "vital force," and that accounted for everything. Whosoever was not satisfied with that explanation was treated to that very "plain argument"—"confound you eternally"—wherewith Lord Peter overcomes the doubts of his brothers in the "Tale of a Tub." "Materialist" was the mildest term applied to him—fortunate if he escaped pelting with "infidel" and "atheist." There may be scientific Rip Van Winkles about, who still hold by vital force; but among those biologists who have not been asleep for the last quarter of a century "vital force" no longer figures in the vocabulary of science. It is a patent survival of realism; the generalization from experience that all living bodies exhibit certain activities of a definite character is made the basis of the notion that every living body contains an entity, "vital force," which is assumed to be the cause of those activities.

It is remarkable, in looking back, to notice to what an extent this and other survivals of scholastic realism arrested or, at any rate, impeded the application of sound scientific principles to the investigation of biological phenomena. When I was beginning to think about these matters, the scientific world was occasionally agitated by discussions respecting the nature of the "species" and "genera" of naturalists, of a different order from the disputes of a later time. I think most were agreed that a "species" was something which existed objectively, somehow or other, and had been created by a Divine fiat. As to the objective reality of genera, there was a good deal of difference of opinion. On the other hand, there were a few who could see no objective reality in anything but individuals, and looked upon both species and genera as hypostatized universals. As for myself, I seem to have unconsciously emulated William of Occam, inasmuch as almost the first public discourse I ever ventured upon dealt with "Animal Individuality," and its tendency was to fight the Nominalist battle even in that quarter.

* "Les formes des anciens ou entéléchies ne sont autre chose que les forces" (The forms of the ancients, or entelechciæ, are nothing else than forces).—(Leibnitz, "Lettre au Père Bouvet," 1697.)

Realism appeared in still stranger forms at the time to which I refer. The community of plan which is observable in each great group of animals was hypostatized into a Platonic idea with the appropriate name of "archetype," and we were told, as a disciple of Philo-Judæus might have told us, that this realistic figment was "the archetypal light" by which Nature has been guided amid the "wreck of worlds." So, again, another naturalist who had no less earned a well-deserved reputation by his contributions to positive knowledge, put forward a theory of the production of living things which, as nearly as the increase of knowledge allowed, was a reproduction of the doctrine inculcated by the Jewish Cabala.

Annexing the archetype notion, and carrying it to its full logical consequence, the author of this theory conceived that the species of animals and plants were so many incarnations of the thoughts of God —material representations of Divine Ideas during the particular period of the world's history at which they existed. But, under the influence of the embryological and paleontological discoveries of modern times, which had already lent some scientific support to the revived ancient theories of cosmical evolution or emanation, the ingenious author of this speculation, while denying and repudiating the ordinary theory of evolution by successive modification of individuals, maintained and endeavored to prove the occurrence of a progressive modification in the Divine Ideas of successive epochs.

On the foundation of a supposed elevation of organization in the whole living population of any epoch as compared with that of its predecessor, and a supposed complete difference in species between the populations of any two epochs (neither of which suppositions has stood the test of further inquiry), the author of this speculation based his conclusion that the Creator had, so to speak, improved upon his thoughts as time went on; and that, as each such amended scheme of creation came up, the embodiment of the earlier divine thoughts was swept away by a universal catastrophe, and an incarnation of the improved ideas took its place. Only after the last such "wreck" thus brought about did the embodiment of a divine thought, in the shape of the first man, make its appearance as the *ne plus ultra* of the cosmogonical process.

I imagine that Louis Agassiz, the genial backwoodsman of the science of my young days, who did more to open out new tracks in the scientific forest than most men, would have been much surprised to learn that he was preaching the doctrine of the Cabala, pure and simple. According to this modification of Neoplatonism by contact with Hebrew speculation, the divine essence is unknowable—without form or attribute; but the interval between it and the world of sense is filled by intelligible entities, which are nothing but the familiar hypostatized abstractions of the realists. These have emanated, like immense waves of light, from the divine center, and, as ten consecu-

tive zones of Sephiroth, form the universe. The farther away from the center, the more the primitive light wanes, until the periphery ends in those mere negations, darkness and evil, which are the essence of matter. On this, the divine agency transmitted through the Sephiroth operates after the fashion of the Aristotelian forms and, at first, produces the lowest of a series of worlds. After a certain duration the primitive world is demolished and its fragments used up in making a better; and this process is repeated, until at length a final world, with man for its crown and finish, makes its appearance. It is needless to trace the process of retrogressive metamorphosis by which, through the agency of the Messiah, the steps of the process of evolution here sketched are retraced. Sufficient has been said to prove that the extremest realism current in the philosophy of the thirteenth century can be fully matched by the speculations of our own time.—*Nineteenth Century.*

## BIRD-MIGRATION.

By BARTON W. EVERMANN.

NINE hundred and forty-one species and sub-species of birds are now recognized by ornithologists as belonging to the avi-fauna of North America. Eighty-two of these may be regarded as stragglers from other countries, and their occurrence in North America as purely accidental. Of these eighty-two species, about twenty-two have been found in Greenland, fourteen in Alaska, fourteen in Florida, thirteen in Texas, and the remaining ones, about a score, in various other parts of the United States—only one or two in any one place, however. We thus have left about eight hundred and fifty-nine species, of which this continent may properly be called the habitat.

About two hundred of these have been identified as birds of the county* in which the writer lives. Twenty-six species of these two hundred are permanently resident here—that is, they rear their young here, and they or other individuals of their species remain with us throughout the year. Fourteen other species visit us from the North, and only in the winter. Besides the twenty-six permanent residents, about seventy-five other species breed within our borders, while the remaining eighty-five species are seen here only for a few days in spring, and again for a short time in the fall. Twice a year they flit by us like an apparition, and we ask: Whence come these birds in spring; where do they spend the summer; and whither do they go when winter comes? Since life of bird and man began, these questions have been asked and studied, but not always have the results been satisfactory.

* Monroe County, Indiana.

It had long been observed that, as the sun comes to our side of the equator, the buds swell, the leaves and flowers unfold, and a sheet of verdure expands and spreads toward the pole; and closely following this there comes a mighty army of bird-life—orioles, tanagers, and warblers of brightest hue—filling every orchard, grove, and woodland with life, and song, and joy. And again, when autumn comes, the wave returns to us from the North, bringing with it the black snow-birds and other species which make their winter home with us, while the great bulk of the species pass on to the southward as mysteriously as they came.

The flight of storks has given trouble to the Germans and the Chinese, while the disappearance and the reappearance of the swallows have caused untold trouble everywhere. Learned bodies, like the French Academy and the Royal Society of London, have gravely asserted that, in the fall, swallows plunge into the mud of marshes and mill-ponds, become torpid, and hibernate like frogs and snakes. I have seen a list of nearly two hundred articles written all along from the middle of the seventeenth century down to 1877, for the purpose of proving or disproving the hibernation of swallows and other birds! And Dr. Coues says he can lay his hand upon papers of that period which discuss the migration of swallows to the moon, the falling of the little quadrupeds called lemmings in showers from the clouds, and the origin of brant-geese from barnacles that grew on trees. Indeed, not a year ago I was assured by a gentleman of more than average intelligence that this last is undoubtedly the correct theory as to the origin of the barnacle-goose! And it was not a decade ago that I read, in one of the leading newspapers of this State, an article of as curious a character. Its purpose was to explain the sudden appearance in fall of the black snow-birds, and their as sudden disappearance in spring, and the explanation given was that our common sparrows change color in fall, becoming snow-birds, which they remain until spring, when they put on their other dress and become sparrows again! And I find that, among the common people of the country, there are many who have this belief.

We have long known in a general way that the birds go southward to winter, and return to spend the summer at the North. But just where in the South do they go? Why do they go there? By what routes do they travel? At what rate of speed? Do they travel by night, or day, or both? What species migrate first, which last, and why? How are they guided in their course? What is the winter as well as the summer habitat of each particular species, when does it get there, and when does it leave the one for the other? In what way and to what extent are their movements dependent upon or influenced by vegetable and meteorological phenomena?

These are but a few of the questions which ornithologists have sought in various ways to answer. The limits of this paper will per-

mit any discussion of but few of these interesting questions. From their very nature it is evident that futile must prove the labors of him who would attempt to solve these problems alone. Only through the concerted action and labors of many observers in different and widely separated regions can any reliable conclusions be reached. Not until recently has the subject of bird-migration been studied systematically in this country or elsewhere.

Three years ago a gentleman* in the Mississippi Valley addressed personal letters to several hundred naturalists, teachers, ministers, farmers, and others in the different Valley States, asking them to co-operate with him in studying the movements of the birds of this region. They were requested to note only the more common phenomena of migration, such as the time of arrival and departure of each species, the time of breeding, and the comparative abundance of the various species. They were asked to record such observations as they could, and send in reports to him of what they had seen. More than one hundred observers were thus secured, who reported to him the results of their observations, and this, if I mistake not, was the first corps of migration observers in America.

A little later, in September, 1883, the American Ornithologists' Union was organized. Among the committees appointed at its first meeting was one on "The Migration and Geographical Distribution of North American Birds." Dr. C. Hart Merriam, of Locust Grove, New York, was made chairman of this committee. It has been and is the purpose of this committee "to investigate in all its bearings, and to the fullest extent possible, the subject of the migration of birds in the United States and British North America. Its work is not limited to the accumulation of records of the time of arrival and departure of the different species, but it embraces as well the collection of all data that may aid in determining the causes which influence the progress of migration from season to season." For example, severe storms, gales of wind, long periods of unusally high or low temperature, are some of the atmospheric conditions which are known to exert marked effects upon the movements of birds.

In order to secure as many observers as possible, and that the material collected by this great army of observers be speedily elaborated, the United States was divided into a dozen or more districts, each of which was placed in charge of a competent superintendent. The superintendent's duties are to secure as many observers in his district as he can, to give them all needed instructions concerning the work, to act as a means of communication between the observers and the chairman of the committee, to collect, at stated times, the results of their observations, and submit them to the committee. The chairman will arrange, condense, and systematize these reports, and present

* Professor W. W. Cooke, then of Jefferson, Wisconsin, now of Burlington, Vermont.

to the Union the fruits of the joint labors of this great corps of observers, together with such deductions or generalizations as he may be able to base upon them.

By noting the species which are permanent residents, which winter residents or visitants, which summer residents, and which spring and fall migrants, together with the relative abundance of each species in each locality where found, the geographical distribution of our birds has already been pretty well made out.

A like series of observations upon the time of arrival and departure of each species, the manner of its coming and going, the period of its stay, the place and time of its nesting, enables us to learn much of its life-history. And a study of meteorological phenomena, such as the direction of the wind, the temperature from day to day, the occurrence of storms, together with data regarding contemporaneous phenomena, such as the appearance in spring of the first frog, toad, or snake; the end of the period of hibernation of certain mammals; the leafing of different trees and the flowering of various plants; and the breaking up of the ice in the rivers and lakes—all these throw much light upon the causes which induce, and the conditions which influence or control, migration.

More than a thousand observers are now at work gathering data for the solution of these problems. Never before have so many persons worked together and systematically for the solution of any great question in science. Observers are at work in every State and Territory in the Union, besides a number in the West Indies, Mexico, and Canada. The interest of the lighthouse-keepers has been enlisted, and many of them are doing excellent service.

The most southern station in the United States is at Sombrero Key, at the southern end of Florida, while the most northern is at Point Barrow, Alaska, more than four thousand miles away. From New Brunswick and Maine on the east, the stations extend across the continent to California, Oregon, and Vancouver's Island. And from the time a bird crosses our southern border in early spring-time until it reaches its breeding-ground, wherever that may be, it is under the careful surveillance of these inquiring spies. Its every movement is watched and recorded, and by the time it has reached its summer home, reared its brood, and returned again to its winter resort, few, indeed, are the important facts in its life-history which have not been made a subject of note by one or another of these observers. Thus the records are made from year to year, and even now hundreds of note-books all over our country contain thousands of entries to the credit or debit of our birds for the last four years. All this, and the Union has just begun its work!

As an illustration, let me ask your attention to the record of a beautiful and familiar bird—the Baltimore Oriole. After spending the winter within the tropics, it returns to our Southern borders in

early April. The record for 1884 shows that it appeared at Rodney, Mississippi, April 7th; at Oxford, April 15th; at Anna, Illinois, April 18th; at St. Louis, April 19th; at Glasgow, Missouri, April 23d; Jacksonville, Illinois, April 27th; Liter, Illinois, and Coralville, Iowa, May 2d; Des Moines, May 4th; Racine and Jefferson, Wisconsin, May 6th; Pine Bend, Minnesota, May 13th; Elk River, May 14th; and Oak Point, Manitoba, May 25th. East of the Mississippi, the record shows that it appeared in Jessamine County, Kentucky, April 18th; at Bloomington, Indiana, April 21st; at Camden, April 24th; Petersburg, Michigan, April 30th; Battle Creek, May 1st; Sing Sing, New York, May 2d; Lockport, May 4th; Painted Rock, May 5th; Locust Grove and Auburn, May 6th; Watertown, May 11th; Lake George, May 13th; Brewer, Maine, May 16th; and Montreal, Canada, May 24th.

The average rate of speed from Rodney to St. Louis was twenty-five miles per day, while the average daily rate for the entire distance —Rodney to Oak Point—was twenty-seven miles. The species seemed to move in greatest numbers about April 29th and 30th, filling up the whole country already reached by the vanguard.

The various reports show that the rate was remarkably uniform throughout the thirteen hundred miles, and that, though it increased very slightly to the northward, it nowhere varied greatly from the average rate—twenty-seven miles per day.

This bird is also very regular as to the time of its arrival at any given place from year to year. For the last four years the first arrivals have been seen here (Bloomington, Indiana) on April 20th, 21st, 20th and 21st. At Camden, one hundred miles north of this place, April 28th, 24th, 21st, 24th, and 25th, are the dates for the last five years. At Locke, Michigan, the record for twenty-five years (from 1856 to 1880), gives April 28th as the earliest date, and May 11th as the latest. The average date for the twenty-five years was May 5th, and it is interesting to know that this average date, May 5th, is the date upon which the first arrivals were seen for *six* of the twenty-five years. But the oriole is a late migrant, and therefore not so greatly influenced in its movements by the weather as are many other species. The late migrants, those which do not begin their northward flight until the weather has become in a measure settled, have been found to be the most regular in their movements. The early migrants are the ones which advance or retreat as the weather favors or prevents. The swallows and martins are excellent examples of this class, and their wide range has enabled them to be studied more, perhaps, than any other birds. As Dr. Coues has said, they are thoroughly cosmopolitan; their northward range reaches into the Arctic zone, and in the South the explorer has never gone so far that he did not find the swallows there. Insectivorous as to food, they must of necessity move with the appearance of insect-life, while their recession from

the North is urged as well by their delicacy of organization and consequent susceptibility to cold, as by a failure in the food-supply. The prowess of their pinion has been the astonishment and admiration of all. The comings of the swallows have passed into proverb, and their leave-takings have been rehearsed in folk-lore among the signs of waning times. They have figured in augury; their flight is barometric, for they *soar* on clear, warm days, and skim the surface of the ground in heavy, falling weather, perhaps neither always nor entirely in the wake of insects upon which they feed. These birds cross our Southern border when the weather is yet cold and changeable. The record for the purple martin for 1884 shows that the first four degrees of latitude were passed at a rate of sixteen miles per day; the next two and one-half degrees at twelve miles; the next four and one-half degrees at sixty-three miles; and the last two and one-half degrees at but ten miles per day—making an average for the entire distance of eighteen miles per day. This record shows us a species very irregular in its rate of speed, and it is easily shown that this irregularity is due to the vicissitudes of the weather.

From observations such as these much has been learned regarding the rate at which various other species migrate. Data on fifty-eight species for 1883, for four hundred and twenty miles, show the average rate to have been twenty-three miles per day. Data on not quite so many species for 1884 show the average rate, for eight hundred and sixty-one miles, to have been exactly the same as for 1883. Twenty-five species gave an average daily rate of nineteen miles for March, twenty-three miles for April, and twenty-six miles for May, thus indicating—what I believe to be true—that the speed at which most species migrate increases toward the northern limit. This was one of the first important facts in migration observed and pointed out by Professor W. W. Cooke, and subsequent observations have all tended to prove the correctness of his views.

Were migration a steady movement, with the same individuals always in the lead, we might determine the exact rate of speed for many different species, but the movement resembles rather a game of leap-frog, and the leaders are constantly changing. Those individuals which arrive first at any given place are the birds of that species which will remain there to breed, while those in the rear pass on farther north. "The vanguard is thus constantly arresting itself, and the forward movement must await the arrival of a new corps, which may be near at hand or far behind. Migration is, then, a series of overlappings, and the real is evidently much greater than the apparent speed."

It has also been noticed that, as a rule, any given species migrates earlier up the Atlantic seaboard or the Mississippi Valley than it does across the more arid plains to the west; the first arrivals appear here from four to seven days earlier than in Kansas directly west of us.

The cause, no doubt, lies in the difference in the character of the vegetation.

One of the most difficult, as well as most interesting, questions in bird-migration has been, How are birds guided in their flight? *By instinct*, has been the usual answer; but, thanks to the labors of such men as Cooke, Allen, Brewster, and Scott, the question is now better understood. Recent observations made at lighthouses and astronomical observatories go to show that many, if not most, of our smaller birds fly at very great heights while migrating—heights even as great as *one to two miles*. And we now well know that "there are certain definite routes or paths along which birds pass in especially great numbers. These are usually coast-lines, river-valleys, or continuous mountain-ranges. Toward these converge innumerable less-frequented paths, each of which in turn has still smaller tributaries of its own. Thus bird-streams, like brooks, flow into common channels, and each particular region may be said to have its bird- as well as water-shed."

Perhaps the greater part of our birds migrate almost exclusively by night, and it seems true that clear, pleasant nights are selected during which to perform their migrations. That most species are unable to foretell the weather, even for a few hours, seems to be true; for during the migrations, if the early part of the night be clear, and a storm or severe rain come up later in the night, the birds will be stopped in their flight. On mornings after such nights I have always found more birds than at any other time. If the rain brought with it any considerable lowering of temperature, the woods and groves would be full of arrested migrants during the next day. These birds had evidently *started* when the sky was clear and the weather favorable.

Keeping these various facts in mind, it becomes quite easy to see how birds are guided in their course. From the great height at which they fly the whole country appears as a map upon which, in the light of moon and stars, the coast-lines, river systems, and mountain-ranges are outlined in every direction for many miles. "Guided by such landmarks as these, the older birds can have little difficulty in following paths they have repeatedly traversed before, and these direct and lead the flight of the younger birds." Mr. William Brewster, in his recent excellent paper on this subject,* and from which I have freely quoted, shows that, while the birds often migrate in waves or flocks, the different flocks do not move independently of each other. He believes that the flocks do not fly in close order, but scatter so as to approach or mingle with the stragglers or advance guard of other flocks, "thus in effect forming a continuous but straggling army, often hundreds of miles in length, and varying in breadth with the character of the country over which it is passing."

But when all is said, a great part of the details concerning the

* "Memoir of the Nuttall Ornithological Club," No. 1. Cambridge, 1886.

facts upon which these conclusions are based, remains to be worked out. Much remains to be done before we can fully understand the forces which impel and enable the bird creation to perform those long and perilous journeys across the depths of air and tracts of ocean, to seek for warmth and food in distant lands, and to return in season to their winter or summer homes.

## A REMARKABLE EXPLOSION.

By Professor L. R. F. GRIFFIN.

MODERN industrial operations necessarily employ great quantities of powerful explosives, of which gunpowder and some of the forms of nitroglycerin are the most important. Nitroglycerin, for convenience in handling, is now commonly absorbed by Richmond infusorial earth, and is then known as dynamite. The use of these substances is not confined to the country, where they can be stored with comparative safety, but many engineering operations in cities require their aid to secure economical construction. This often necessitates their storage in considerable quantities, so that it becomes a source of danger. Special precautions are necessary to reduce the danger as much as possible, and to confine the effects of any accidental explosion within the narrowest limits. Usually, making the buildings used as magazines low, with strong walls and very light roofs, has been considered sufficient. Then, if explosion comes through accident, the explosive material spends its force upward, and the only damage to neighboring property arises from the shock given to the air. This plan may have been ample protection when gunpowder alone was stored, but the large substitution of dynamite in blasting has led to storing that explosive in the magazines, and a recent occurrence dangerously near Chicago has shown that it is by no means sufficient.

On Sunday morning, August 29th, Chicago and places in its immediate vicinity were startled by a sudden jar, followed by a dull thud, as of a distant gun of large size. It was sufficiently violent to shake buildings six miles distant, so that, although a very severe thunder-storm was occurring at the time, guests in some of the hotels rushed frantically down-stairs, suspecting an earthquake. Plaster fell in the Immanuel Church, more than five miles away, so that it was at first supposed to have been struck by lightning, and a large plate-glass window in the Board of Trade building, about seven miles distant, was cracked, and the clock on its tower was put back three seconds. An examination showed that Laflin & Rand's powder-magazine, one of a group of eleven, standing on a comparatively open area of some forty acres, about a mile and a half west of the village of Brighton,

seven miles distant from the center of the city, had exploded, being struck by lightning. It contained at the time some fifty tons of ordinary gunpowder and fifteen tons of dynamite. The brick walls of the building were pulverized and scattered over a wide area; the limestone foundation was torn up, and a large part of the material broken into small pieces, the most of it carried through the air from forty to eighty rods; and a hole was torn in the ground, there mainly tough clay, about one hundred and fifty feet long, forty feet wide, and from ten to twenty feet deep. All the buildings in the immediate vicinity were demolished, while those which stood within reach of the flying stones were more or less riddled. The loss of life was very small, considering the extent of the damage, only one person having been killed outright, although several others were severely injured, of whom some have since died.

Such are the primary facts connected with the explosion itself. An examination of the ground in the vicinity, and of many of the buildings ruined near by, together with others at considerable distance more or less injured, has developed certain minor facts that bear upon the general subject of explosions. Especially do they seem to show that such explosions may produce an earth-wave which may do damage at great distances, the undulation of the ground displacing objects, cracking walls, and shattering glass much like an earthquake in miniature. Sometimes this may possibly prove the source of the principal destruction.

Looking directly at the destruction itself, the results of the explosion appeared as follows: The buildings nearest the wrecked magazine were all crushed together, and, so far as could be determined from the ruins themselves, were pushed away bodily from the demolished building for a short distance, not more than one or two feet. This shows that the explosives instantly produced a very large volume of gas, which forced itself against the surrounding air, and condensed it very quickly, until it gave way in the direction of the least resistance, which would necessarily be upward. This condition was confined to a small circle, for, while such a condensation would produce a wave of air, the mass bodily displaced must be confined within comparatively narrow limits. Displacement would not appear beyond. Fortunately, at Brighton, no other magazine stood within this area, so that the dynamite in the others was unaffected by the shock, while the rain prevented the fire from spreading by means of dry powder. Outside of this area there was a narrow ring or circular strip of ground with a radius of not far from fifteen rods where comparatively little injury was done. One or two magazines stood in this region, and they escaped almost without injury, only being slightly battered by flying stones. Here the air was not moved as a mass either way. The changes of density to which it was subjected were of the nature of molecular movements rather than motion of any great mass of air.

Beyond that area the movement of the air was toward the point of the explosion. This was shown by the forcing of the glass outward in all of the more distant buildings, while the walls of at least one dwelling-house and of several of the magazines left standing were thrown down toward the wrecked magazine. Furthermore, the roof of one magazine was clearly lifted, and allowed to drop, besides being riddled with stones. These phenomena pointed clearly to diminished pressure of the external air produced by the explosion, as is noticed in a small way when any gun is fired. Since most of the magazines stood in this region, no blow was struck upon them, and there was nothing to explode the dynamite stored within, else the first explosion would have been followed by others in a series, and the damage multiplied.

These phenomena taken together seem to indicate the following as the steps by which the destruction was produced, though they followed so quickly that only delicate instruments would have distinguished them: First, the lightning exploded some of the black powder. The blow produced by this explosion detonated the dynamite, tearing up the ground to make the hole and breaking the foundation-stone into small pieces. Then the rest of the powder exploded, sending the fragments away in all directions.

It is very strange that when the danger from lightning is so well known—one of the same group of magazines was exploded by lightning in 1880—no precautions are taken by the owners for protection. The magazines are low structures, some of them roofed with slate, others with thin metal, in all cases very light, that they may offer but little resistance in case of explosion. The total neglect of precautions against lightning indicates a disregard of the known laws of electricity, or else the mistaken notion that a lightning-rod, by furnishing a good conductor, attracts the lightning, and thereby increases the danger in place of being a safe path for the current. When such buildings stand upon level ground, in open areas, they necessarily become the path of any descending flash. If the electricity goes through the building it becomes a source of danger, because it is likely to meet sufficient resistance to raise the temperature above the igniting-point of powder, and it must be carried completely around the powder to insure safety. A network of metal rods carried over the top of those whose roofs are slated, and given a sufficient ground connection, would be a complete protection; it would carry away all the electricity, usually silently. To protect those with metal roofs, nothing more would be required than wide strips of metal from the roof itself to the ground. Of course, in either case, great care must be taken to prevent scattering powder on the ground within reach of the electricity as it leaves the conductors. The problem of protection in this case has sometimes been compared with that of the protection of tanks in which petroleum is stored. This is a complete misconception. Protection of powder-magazines simply requires a proper conductor to carry off the elec-

tricity, silently if possible, but so completely as to allow no escape in case of a flash. There are no complicating conditions, such as petroleum-tanks present. Nothing, either in the material itself or in the air around, makes that a better conductor than neighboring objects. But, in the case of petroleum-tanks, gases are constantly rising from the petroleum and escaping into the air around, and particularly directly above. They frequently rise many feet above the tank, and experience proves that the gas, or the mixture of the air and gas, is a much better conductor than the air itself. So the tank is likely to become the path chosen by any descending flash, and the problem of protection is not simply to furnish a conductor from the top of the tank, but one that shall conduct the electricity from the top of the ascending gas, always an uncertain height. So far, no plan has proved completely successful.

The phenomena show clearly that two sources of danger arising from such terrific explosions must be guarded against. The glass broken within the first two miles proved a rush of air toward the destroyed magazine. The sudden up-rush of gas, the mass very highly heated, caused a vacuum, and the subsequent cooling added to the effect. The air rushed toward that vacuum from all directions, and when it was contained in a confined space, as a closed room, it quickly broke the glass, shattering it into small fragments, which fell outward. But the force which did this work was spent within a comparatively narrow area. Beyond that it only appeared as the back-and-forward movement of an ordinary sound-wave. The distance to which this was carried could not be determined, because beyond some seven or eight miles the report was not distinguished from the ordinary roll of the thunder.

This explosion produced an earth-wave as well as an air-wave. The force of the dynamite, exerted largely downward, not only tore the ground out to make the hole, but forced it away sidewise in all directions. This formed a ridge around the hole, and at the same time it produced a wave, that is, an up-and-down movement in the earth. One observer, who was sitting quietly in a chair about six miles from the magazine at the time of the explosion, described the sensation which he felt as a quick movement down and up again. He was not quite positive which preceded, the motion upward or downward, but he thought that downward. That would indicate that the upward motion of the earth was first, since the human body has the sensation of moving in the opposite direction to the motion of the wave, and that agrees with the appearance of the hole. This earth-wave made dishes rattle in all places where it was felt perceptibly. In the central part of Chicago many plate-glass windows were cracked. These were injured by the earth-wave, not by the air-wave. They were simply shattered from the motion of the surrounding walls, but were not forced either inward or outward. One observer stated that a pane of

glass near him was cracked at the moment when he felt the shock, not when he heard the report, which was a little later. This shows that the earth-wave moved faster than the air-wave which produced the sound. There is also reason to believe that this earth-wave traveled much farther than the air-wave. A self-recording barometer in the laboratory of Lake Forest University, about thirty miles distant from Brighton village, showed a sudden movement of the mercury at about that time, which could be accounted for only by referring it to the wave of the explosion.* Probably this was not the limit of the movement. Unfortunately, there were no means of determining the rate at which this earth-wave moved. All these conditions combine to surround this remarkable explosion with peculiar interest.

## THE SCIENTIFIC AGE.†

By Dr. WERNER SIEMENS.

THE Association of German Naturalists and Physicians, which is so numerously and brilliantly represented here, having sixty years ago raised the banner of free investigation in our fatherland, has since, by its meetings, held from place to place, made the sciences, which had been previously pursued only in the narrow circle of experts, accessible to the life of the public, and therefore serviceable. The step was one fruitful in results. With it began a new age for mankind, which we have a right to call the scientific age. Nature had, indeed, given to primitive man — only weakly equipped in bodily strength — mental power and the faculty of observation, as the strongest of all weapons, in aid of his struggle for existence, and had taught him something of the use of her forces, his growing knowledge of the suitable application of which early smoothed his way to a higher civilization; and the arts of the earlier ages could be developed in many fields to a height at which we may still wonder, and means could be afforded for the achievement of artistic results of a perfection which has not since been reached; but all this came about by the toilsome and often fallacious way of the accumulation of empirical, uncomprehended, and unconnected observations and experiments, or by a way which could only slowly lead to the development of higher degrees of civilization.

These stages in civilization, however, comprised only a narrowly limited circle of development, and constancy was wanting to them, for they were attached to the person, and perished with it. Hence we see that, in the course of time, many eras of local civilization have bloomed

* The same instrument clearly recorded the earthquake-movement of the evening of August 31st.

† An address delivered before the meeting of German Naturalists and Physicians, in Berlin, September 18, 1886. Translated for "The Popular Science Monthly."

out, to disappear amid the commotions of the following age without leaving a trace behind them. Even after the art of the mechanical multiplication of writings and pictures had made the achievements of mind the common good of mankind; after the foundations of our present science had been laid, and it had been recognized that unchangeable laws lie at the bottom of all natural phenomena, and the only sure way of learning these laws lay in questioning Nature herself, through properly directed experiments—still, scientific and technical progress was toilsome, slow, and insecure. There was still needed a coming out of learning into public life, an infection of empirical art by the spirit of modern science, to release it from the ban of the traditional and mechanical and raise it to the dignity of a scientific art.

We older men among you have had the good fortune to be witnesses of the immense impulse that has been given to human activity, in nearly all departments of life, by the vitalizing breath of natural science. We have also seen, on the other hand, how science has been advanced by the achievements of art; how art has brought to it a fullness of new phenomena and problems, and with these the stimulation to further investigations; and how, with the spread of scientific knowledge, a host of observers and fellow-workers have grown up to her, in whom, although they may not stand on the full height of scientific knowledge, the love of science has repeatedly made up for that lack.

I will not attempt here to follow up the history of the growth of natural science, and its offspring, scientific art, or to describe the powerful transforming influences which science and art together have exercised upon the spiritual and material development of our period. It has been done many times, in convincing words and a masterly manner.

For us older men it suffices to acquire a view of the great difference between the past and the present—to cast a brief glance back to our own youth. We can still recollect the time when steamboats and locomotives made their first feeble experimental trips; we still hear with credulous astonishment the news that light itself can be made to paint the picture which it renders visible to our eyes; that the mysterious new force, electricity, could transmit news with the velocity of lightning through whole continents and the oceans separating them; that the same force would separate metals, in fixed form, from their solutions; and that it could drive away the night with a light as clear as that of day. Who wonders to-day over these now self-evident things, without which our youth could hardly imagine a civilized life—to-day, in an age when, according to Reuleaux's calculations, several iron laborers work day and night for every civilized man; when millions of men and immense quantities of goods are carried great distances at velocities which were once hardly conceivable; when the world-binding telegraph is not sufficient for the wants of our commerce, and has to make way for the transmission of the living word through the tele-

phone; when photography is at the service of all classes; and when the latest fruit of the association of science and art, electro-technics, is opening to man, in its rapid unfolding, ever-new regions of inconceivable extent for further research and useful applications of the forces of Nature? To the investigator—who, more than any other class of men, is accustomed to draw conclusions from the course of observed phenomena as to the law controlling them—it is, however, not the latest state of development, but its causes, and the laws on which they depend, that are of surpassing importance. The clearly recognizable law is that of the progressive acceleration of our present advance in civilization. Periods of development, which in former times required hundreds of years for their accomplishment, which in the beginning of our age needed decades, are now completed in years, and sometimes come into being in full perfection. This is the natural result of our highly perfected system of instruction, by which the acquisitions of science, and particularly the scientific method, have been introduced into the broad stream of art and popular life in all their forms of efficacy.

Thus we see how, by virtue of our now excellent system of communications, every new scientific thought is at once flashed through the whole civilized world, and how thousands endeavor to grasp it and to apply it in the most diverse spheres of life. Sometimes it may be only modest observations, sometimes only the overcoming of small impediments that stand in the way of the recognition of the scientific relations of phenomena. They may often be the point of departure for a new course of advance, previously quite unanticipated, but important for human life. The progressive development conditioned upon these principles will therefore continue, if man does not himself in his conceit interrupt it, as long as science keeps going on to higher degrees of knowledge. The deeper insight we get into the secret processes of Nature, the more we are convinced that we are still standing in the extreme outer court of science, that an as yet immeasurable field of work lies before us, and that it still appears at least very questionable whether man will ever reach a complete knowledge of Nature. There is, therefore, no ground for doubting the continuance of the progressive ascent of scientific and technical evolution, unless man himself interferes with it by conduct inimical to civilization. But even hostile attacks can henceforth cause only temporary interruptions in the course of development, or at most only partial reversions, for, in the presence of the printing of books and the wide diffusion of the results of modern civilization, the scientific and technical accomplishments of mankind can never again be lost. Moreover, the peoples who cultivate these arts and lift them higher acquire through them such a dominant ascendency, so great a fullness of power, that their subjection in the contest with uncivilized people, and the breaking out of a new barbaric age, appear impossible.

While we thus regard the present development of civilization as

incessant and impregnable, the end to which it is tending remains hidden to us; but we can discern from its beginnings the direction into which it is to turn the principles on which popular life has hitherto rested. For this purpose we need only to carry out further the changes which have been already begun. We can then easily perceive that, in the age of the reign of the sciences, severe manual labor, by which man has been very hardly and still is considerably oppressed in the struggle for existence, will be more and more reduced by the increasing utilization of natural forces in mechanical service, that the work that falls to man will become continually more of a mental character, while it will be his part to direct the work of iron laborers (or machines) but not himself to perform rough bodily labor. We see, further, that in the scientific age the necessaries of life and luxuries will be supplied with far less human toil, and that a much larger share of these products of labor will fall to each man at the expense of less working-time. We shall see, also, that, through scientific and properly directed cultivation, a very much larger quantity of food-products will be obtained from the soil than heretofore, and that the number of men devoted to this branch of industry may be correspondingly diminished. We shall find that through the improvement and greater expedition of communication and transportation an ever-more ready exchange of the products of different lands and climates will be made possible by which the life of men will be rendered more enjoyable and their existence assured against the consequences of local scarcities. It also appears very probable that chemistry in connection with electrotechnics will some time succeed in composing real food-substances out of the inexhaustible abundance of their elements everywhere present, and thereby make the number of those who may be supported independent of the ultimate productive capacity of the soil. This progressively augmenting facility in obtaining the material means of existence will, by the shortening of the working-time that will have to be applied to that purpose, afford to men the leisure they will need for their better mental cultivation; the better perfected and cheapened making of mechanical reproductions of artistic creations will also prepare the way for bringing these works into the cottages, and will make art, beautifying the life and elevating the moral standard, accessible to all mankind, instead of to privileged classes only. We are strongly of the conviction that the light of science, penetrating more deeply into the whole of human society, combats in the most effective manner degrading superstitions and destructive fanaticism, and that we shall be able therefore to go on in proud satisfaction with the building up of the age of science, in the sure prospect that it will lead mankind to a better moral and material condition than it has been or is enjoying to-day.

Our complacency on this subject has been disturbed very recently by gloomy pessimistic views which have been formed in learned circles

as well as in the broad popular strata, respecting the influence which the rapid advance of science and art is exercising upon the character of popular life, and respecting the end to which that advance is tending.

The questions have been raised and discussed whether man is really better and happier for all these achievements of science and art, or whether they do not rather lead to the destruction of all ideal qualities of good, and to a coarse pleasure-seeking; whether the inequality in the division of the goods and pleasures of life will not be magnified through them; and whether the opportunities for work of individuals will not be diminished through the growth of machine-industry and the division of labor resulting from it, and the laborer himself be brought into a more restrained, dependent condition than before; or, in short, whether, instead of the lordship of birth and the sword, there will not prevail the still more oppressive rule of inherited or acquired wealth.

It can not be denied that there is now some show of justification for these gloomy anticipations. The rapid and continuous advance of scientific technics must necessarily, as it goes on, have a disturbing effect on many branches of industry. Better working methods may in many ways cause production to rise faster than consumption, and reduce the demand for labor, while manual labor, which formerly employed a much larger number of workmen to produce the same results, will no longer be able to compete with special machines. The like may be observed in the production of food-materials. Cheaper means of transportation are bringing to the old civilized lands the products in masses of thinly inhabited regions, whose virgin soils are not yet in need of artificial fertilization, but in which the scarcity of labor has led to the perfection of mechanical processes. It is true that scientific art provides means of equalizing these disadvantages by more rational methods of fertilizing and working; yet it is very hard to replace old accustomed but untenable conditions by better ones. Complaints are multiplying over the general depression in prices, and the falling off of the demand for labor, and the strangest theories are proposed for curing these evils by the isolation of certain lands against the products of others, and by forced limitations of production. The adherents of such theories go so far as to deny all utility to mankind of the scientific tendency, and to dream of a return to the methods of former presumed happier days. They do not recollect that, in this case, the number of men would also have to be brought back to the old figure. The number of happy shepherds and huntsmen is very small, and yet it must enter as an essential factor into the estimation of the greater or less prosperity of any period. It is a very hard but at the same time an unalterable social law, that all transitions to other, even if they be better, conditions, are connected with suffering. It is, therefore, certainly a humane proceeding to alleviate these sufferings to the present generation by a careful direction and partial limitation of the new,

continually reverting revolutions of the social conditions of popular life; but it would be hopeless to try to stop the stream of this development, or to turn it back. It must necessarily follow its predestined course, and those countries and peoples will be least affected by its disturbing influence, and will be the first to participate in the benefits of the scientific age, which do the most to bring it on. But that the coming age will really present better conditions to mankind, and will heal again the wounds that it makes, notwithstanding the unavoidable inconveniences of the transition to new modes, is recognizable from many signs.

Is not the generally apparent lowering of the prices of all the necessaries of life and products of labor with a simultaneous, vastly increased consumption, an indubitable evidence that the human labor required to provide them has become less as well as lighter than before? And that the tendency of the development is such that men in the future will have to labor a much shorter time to provide for their needs? Does not also the fact, evident at the same time, that wages are not falling in a corresponding degree with prices, show that the lot of the working-classes will be a continuously improving one as the scientific age advances? Cheaper production of necessaries means the same thing as higher wages. Higher wages, and shorter hours of work! This louder and louder sounding demand of the so-called working-classes will be realized, therefore, as the natural result of scientific progress. For, except for crises and states of transition, no more will be made than is used, and the average time of work will of necessity diminish with the augmented speed and ease of production.

Another generally evident fact is the reduction of interest. To discern the significance of this fact, we must keep in view that capital—the savings of wages, as political economy calls it—is the standard of value of all wealth. His own or borrowed capital enables a man to obtain the usufruct of the labor of other men. If capital were really abolished, as fanatical and mistaken men are trying to have done, mankind would fall back into a condition of barbarism in which every one would be relegated to the work of his own hands for the provision of necessaries. But the demand for capital can not keep pace with its increase, because the arrangements for the production of goods are growing more facile, simpler, and cheaper. There is, therefore—always allowing for the transitional variations and violent disturbances of natural progress—a larger average accumulation of capital than can be usefully applied; or, in other words, an overproduction of capital is taking place, which must find, and is, in fact, already finding, its expression in a reduction of the rates of interest. The value of the savings of former labor, or of capital, will, therefore, continue to decline in comparison with the labor of the present, and must in the course of time be annihilated.

For the other and seemingly the most weighty objection of the

opponents of our social progress—that by its operation the larger number are condemned to work in large factories, and that in the progressive division of labor no room is left for the free exertion of individuals—for this, also, the natural course of the advance of the scientific age bears the remedy in itself. The necessity of large factories for the cheap production of useful articles depends essentially on the present imperfection of machine technics. Large machines just now give cheaper effects than small ones, and the introduction of the latter into the houses of workmen is still beset with great difficulties. But ingenuity will certainly succeed in overcoming the impediments in the way of the return to competitive manual labor, by bringing cheapened mechanical powers, the basis of all industry, into the smaller shops and workmen's homes. Not a number of great factories in the hands of rich capitalists, in which the "slaves of toil" shall wear out their hard existence, is to be the ending of the development of the age of science, but the return to individual labor, or, where the circumstances call for it, the conduct of co-operative establishments by associations of workmen, for which a sound basis has first been furnished by the general spread of knowledge and training, and the possibility of a cheapened supply of capital.

The complaint is likewise unjust that the study of science, and the application of the natural forces to the arts, give a material tendency to men, making them vain in their knowledge and power, and diverting them from ideal aims.

The more deeply we look into the harmonious administration of the powers of Nature, regulated by eternally unchangeable laws, yet so profoundly veiled from our full understanding, the more, inversely, we feel ourselves moved to an humble modesty; the smaller appears the scope of our knowledge, the more earnest is our effort to draw more from this inexhaustible fountain of knowledge and power, and the higher rises our admiration of the infinite regulating wisdom which pervades the entire creation. And the admiration of this infinite wisdom gives a new stimulus to that spirit of investigation, that devout pure love of knowledge, which finds its final object in itself, which has been lifted to a position of high honor in the German scholar, where it stands a hopeful mark to future generations.

Hence we should not be disturbed in our faith that our zeal in investigation and discovery will raise mankind to higher grades of civilization, will ennoble it and make it more amenable to ideal efforts, and that the dawning scientific age will diminish its suffering and disease, heighten its enjoyment, and make it better, happier, and more satisfied with its lot. And, although we may not always see clearly the conviction that the light of truth which we are seeking for will not lead us into error, and that the fullness of power which it gives to man can not depress him, but must raise him to a higher degree of the way that leads to these better conditions, we shall yet hold fast to being.

# ON THE TRUE AIM OF PHYSIOLOGY.*

By Professor W. PREYER,
of the University of Jena.

FOR a long while I have felt the desire to answer in a popular treatise the question, What ways and aims ought physiology to pursue? Most naturalists consider the explanation of all phenomena, including those of living bodies, only satisfactory if mechanical—that is to say, if, in strict logical sequence, it is based upon the principles of modern physics as taught by Galileo nearly three centuries ago. Thus, G. Kirchhoff considers the highest aim which the natural sciences have to strive for to be the discovery of the "forces" existing in Nature and of the condition of "matter"; in other words, "the explanation of all natural phenomena by means of mechanical laws." The fact that besides the forces, which mechanics has to deal with, there exist, too, chemical forces independent of the former, is illustrated by an hypothesis: "The same particles of matter, which at a greater distance affect each other only through gravitation, manifest, when placed in proper proximity, molecular forces, which appear in their protean forms, now as forces of elasticity, of cohesion and adhesion, now as forces of chemical affinity." The proof to what extent chemical affinity is a molecular force dependent on the unequal proximity of bodies affecting each other chemically, is wanting. It also remains an open question whether at greater distances masses act upon each other only through gravitation. But, lest it should be inferred that inorganic nature only must be explained mechanically, Professor Kirchhoff, in accord with many naturalists, adds: "We must confess that at present we possess but little knowledge of the condition of matter as well as of the forces through which its particles act upon each other, and that our comprehension of natural phenomena, even of those connected with inorganic bodies, is as yet very imperfect. The same may be said with respect to the much more complex processes which take place in plants and in animate bodies. In either case a true conception can not be formed so long as the mechanical theory has not been satisfactorily demonstrated. This goal never will be reached by the natural sciences, but the mere fact of its having been recognized as such gives a certain satisfaction, and in approaching it we experience that highest enjoyment which the investigation of the phenomena of Nature affords."

I am unable to share that satisfaction, since I do not recognize such a goal as the true one, nor does the approach to it afford that high enjoyment, because of our progress being constantly impeded by facts. The processes in a living body, even in mere protoplasm, can not pos-

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sibly be entirely based on mechanics, nor can we meet the difficulty by substituting for "mechanics" the highest physics and chemistry, including consummate molecular mechanics. For physics treats only of phenomena dependent on motion—that is, changes in space, the forces, the causes of motion, and the causes of changes in motion, as formulated by human intelligence, are its proper domain. Chemistry, which ascribes to Nature one single force—that of affinity—because it does not need any other, deals with substances alone, with the various elements of matter. Processes which can not be attributed to either changes of forces, i. e., change of one force into another, or to changes of substances, i. e., the transformation of the latter through separation and combination, are not physical and not chemical; consequently, neither physics nor chemistry is engaged in their investigation. Such processes, however, take place in animate bodies—the feeling of hunger, for instance, which the most thorough physical and chemical inquiry fails to explain, though its necessary conditions and consequences may be ascertained.

During the fertilization and division of the ovum, during the differentiation of embryonic forms, during the gradual transformation of fetal and aimless into functionary movements of muscles and nerves, and during the perfection of the organs of sense and of the nerve-centers after birth, a series of processes occur which are entirely outside the domain of both the physicist and the chemist. They are not called upon to deal with the problems of heredity and psychogenesis, as they do not present themselves in the physical and chemical world.

For the very reason that there is *one* world only, all dualistic systems are untenable. The mechanical theory asserts, though illogically, that, by means of its one-sided principles, all things will in time be understood. The dualistic or vitalistic theory starts by assuming the existence of a contrast in the world, the forces in the living body being different from those in the crystal, those in the brain not the same as those in the material of which the brain is composed, those in young protoplasm not the same as in the old. Now it devolves upon physiology to show how to eliminate this "vitalism" which encumbers its path. Physiological inquiry must attach more importance to the conception of evolution. Morphology, in applying the method of evolution in all its departments, has gained a higher repute than ever. The anatomical phylogenetic history of man, in connection with his embryological and later history of development, may indeed furnish an explanation of the marvelous fitness and natural evolution of the human body.

It is, therefore, surprising that in that domain of the science treating of living bodies, in physiology, or the science of the functions, it hitherto has not been applied at all, or only occasionally and reluctantly. The neglect is due partly to the erroneous opinion that not the physiological function, but only its substratum the bodily organ, is

capable of evolution. The organ, that much is certain, develops—that is, it passes through a series of transformations before assuming its final form: Any part of every organism will furnish the proof. But what determines the final form during phylogenetic evolution? I answer, Function. With its assertion begins the differentiation of the substratum of primitive beings. It is not the organ from which function derives its origin, but just the reverse. The functions create their organs, or, to use a better definition, necessity determines the organic form, which hence becomes hereditary, and ultimately in the embryo of the higher animals in structure at least precedes function.

When the embryo of the land-salamander, many months previous to the normal time of its entry into the world, is taken out of the egg and kept in water well supplied with oxygen, neither too warm nor too cold, nor too dark, and amply fed with small living water-animals, and if care is taken that the creature can not get out of the water, its organism will change. It has to inhale the oxygen dissolved in the water, not that of the atmosphere, like its parents breathing with lungs. Its lungs therefore remain undeveloped, but by way of compensation strong gills appear at each side of the head. The originally very feeble function of respiration through gills, in conformity with the increased demands of the growing body, creates a new organ, or calls forth one possessed by its remote ancestors. The animal, moreover, feels the necessity to swim, not to creep, like its terrestrial parents. Its four extremities, therefore, become mere rudimentary appendages, while, on the other hand, a vigorous rudder-tail develops. The function of swimming calls forth fins, new organs which the parents lack. Thus a substantially new animal is produced, which elsewhere does not exist, and which shows how through the development of new functions new organs are formed, or, as it were, resuscitated.

This principle applies not only to particular cases with artificially created conditions but to all functions. All of them precede the organs devoted to their exclusive service. All of them originate through competition for the necessaries of life. At first a simple want is easily satisfied by simple means, but gradually the organism is called upon to meet numerous demands requiring complex contrivances through differentiation.

Instruments, apparatus, engines, are tools or organs invented by human beings, because the wants of better food, better air, better water, or the necessity of saving space and time, or of having means of communication, protection etc., become more and more pressing among them. They have, as it were, become part of the organism. Such newly invented artificial organs as the spectacles, the watch, the shoe, have all a long history of evolution.

The kitchen, with all its large and small utensils for the cooking and mixing and chemical preparation of the raw produce of the animal and vegetable kingdoms, may be looked upon as one single digestive

apparatus, an ante-stomach whose history of evolution, covering thousands of years, distinctly shows the increasing demands for digestibility and relish, the need to diminish the work of the teeth and to ease the process of mastication. The starting-point is here the function of taking and assimilating food.

In this sense it is not only permissible but necessary to speak of an evolution of physiological functions. No organic structure develops without having an activity, a necessity, to intensify this activity for its cause. The cause of this increase in activity or differentiation is simply functional evolution. It is the principle of all organic growth, of all morphological evolution, and, wherever it decreases or ceases, the latter at once retrogrades. Without function, no organic formation; increase of function, organic differentiation; cessation of function, organic retrogression.

In applying this principle to the physical and mental activities of the healthy and the sick human being, physiological inquiry must of necessity be carried on in two directions. Since it is necessary to know not only the nature of functions, but also how they have evolved, the evolving living body, the embryo, must be physiologically examined. That is one direction. To compare the complex functions of man, the most complex of all beings, with the less perfected functions of animals—and of plants too—is the other task. Physiology must be comparative only, said, in 1826, Johannes Müller. The genetic and the comparative science of functions go together. Both, as yet incipient, must by-and-by become the basis of the biology of the future.

Each single function of man must step by step be followed back to its first manifestation in the living ovum, in the individual life, and in that line of animals which nearest approach his ancestors, and hence further up to the merely living protoplasm which is neither animal nor vegetable. It then may dawn on us whence are derived the high and lower functions—e. g., speaking and seeing, as well as breathing and walking, and how they have become as they are.

But if we continue to inquire without comparing, we can not arrive at such knowledge; but by merely observing in which way in *one* instance a function is performing, we may, with great expenditure of labor and ingenuity, time and material sacrifices, find only how it may be or may have been, not how it is and has been. The preference since Galvani's time for the frog as an object of physiological inquiry, the too frequent use of dogs, rabbits, and Guinea-pigs, already called the domestic animals of physiologists; and the levity with which the discoveries made on these few animals, so widely differing from man, have sometimes been applied to the latter, have caused many errors. It is gratifying that at least some of the younger investigators choose also other objects of inquiry, but they should not be the exception. By no means can it be urged that it is too difficult to procure the material, and that in zoölogical gardens physiological laboratories can not

well be established. Not every physiologist will, like the great Harvey, get a deer-park placed at his disposal by his king; but the forests and fields, the lakes and rivers of Germany yield abundant material to the investigator, and with our modern means of communication living animals may be quickly dispatched from zoölogical gardens to physiological institutes. The latter, however, avail themselves too little of their opportunities.

All the working material that can be obtained in this way, however, is but a very small fraction of what the sea affords, and he who earnestly desires to further comparative physiology without laboriously hunting for objects for examination must go to the sea-shore. But in order better to approach the end in view without waste of time, laboratories for physiologists ought to be constructed on the coast, especially in places where varieties abound. The aquaria which are being erected in increasing numbers in Great Britain and France are admirably adapted to the purpose. The zoölogical station at Naples, however, which owes its existence to the tireless energy of Professor Anton Dohrn, has as yet no equal. Its scientific achievements, its international character, its admirable organization, its favorable location, make it, for purposes of physiological and morphological investigations, especially desirable. Having enjoyed the privilege of working there during one winter, I am able to speak from experience of the eminent services which the high-minded founder and manager of the Naples Institute, the first of its kind, has rendered to the furtherance of the true physiology. He, the first to accept functional change as the principle of morphological and philogenetic inquiry, has also been the first to recognize the advantages of the physiological investigations of marine animals.

It must frequently pain a naturalist to witness how untold living treasure coming from the sea up to the surface in aquaria is allowed to return to the dark deep as unworthy of observation and examination. And yet by experimenting on the superabundant and to the physiologist irresistible wonders of the sea, more light may be thrown on the relations of the phenomena of life, on the becoming and being of the higher and the highest, and also the mental functions, than is to be obtained by limiting ourselves, as has been the custom, to a few animals of our own geographical environment. When, for instance, we observe how star-fishes, generally supposed to be capable of reflex movements only, will free themselves from fetters and difficult situations, like highly intelligent beings, in an amazingly dexterous manner and with the nicest adaptiveness, how, with the precision and alacrity of expert gymnasts they will vault from a piece of driftwood on to the solid rock, or, while freely suspended, will change the dorsal attitude into the normal one, remove entangled obstacles with their long spikes braced against each other as circumstances require, like long-armed or short-armed levers, and otherwise accomplish unexpected feats, we have

the proof not only that the prevailing views in regard to the lack of intelligence of such low organisms of the animal kingdom are erroneous, but also that their mental functions may be highly developed without such intricate development of the nervous system as is possessed by the higher organized beings of less psychic capability. I have witnessed how a South-Sea Islander was unable to take off a coat which had been put on him in the regular way. It did not occur to him to stretch one arm backward. The star-fish, however, easily frees itself in the best possible manner from rings, firmly knotted threadings, wrappings, and incumbrances, with which it has not previously come in contact. Such observations must necessarily influence the principles of inquiry. A large brain is required not for one single intellectual act but for a multiplicity. I have found that when many of the tiny ganglionic cells of the Echinodermata remain in organic connection with only one spike, they are capable of doing more work both as to quantity and quality than a smaller number will accomplish under the same conditions. Hence it would appear that also with the higher animals, and with man, the greater intelligence depends on the greater number of ganglionic cells and their combined action rather than on the relatively larger brain. In this way the inquiry into the movements of marine animals directly leads up to the physiology of the brain. Through comparison with that of the animal only is human psychic activity to be understood, for it is the last and highest link of a long chain of evolution whose gradations can only be recognized by the aid of philogeny and physiology—i. e., through the comparison and the history of evolution of functions.

The most attractive problems of the future lie in this direction, and, as soon as the labors in this field have borne more fruit, the different views which now oppose each other will become reconciled. But in other departments of science, too, the perception is dawning that it is of far greater significance to ascertain by comparison the becoming, the growing, the evolution, than to describe the phenomenon by itself just as it happens to present itself to the observer whenever he thinks fit to observe.

In 1861 one of the foremost chemists of the period declared, "The relations of a body to what it has been and to what it may become are the essential part of chemistry" (Kékulé). Instead of "chemistry," we might just as well say "morphology, or history of evolution." The same principle applies to physics, to astronomy, geology, and in a certain sense even to the science of languages. For physics, too, deals with the relations of a conglomeration of forces or of a body to its own past and future. Its ideal is to predict the future of a body, and to estimate its past from its present appearance. Astronomy, in this respect, surpasses all sciences, because its prophecies are being verified with most precision. Geology is essentially the history of the evolution of the globe; comparative philology endeavors, as it were,

to find out, from the relations of living languages to the dead and living ones, the pedigree of each idiom, just as the zoölogist is trying to discover the origin of present animals from their relations to the fossils and to each other. Everywhere thinking naturalists are tacitly or confessedly influenced by ideas closely resembling the conception of evolution. All are anxious to ascertain the past and future conditions from existing ones, which is the very essence of evolution. The nature of the transition of one condition into another, its laws, its velocity, its consequences, all these differ in the special departments, not the general fact of the change of condition itself. When, at the same time, the sunbeams warm the human body and delight the eye with glowing colors, when they dye the young plant green and the sensitive glass plate violet; when they move the radiometer, make the telephone resound, allure millions of tiny winged insects into the air, banish millions of other beings which shun the light under ground and to the depths of the waters, close night-blowing flowers while opening others bedecked with dew at the dawn of day—it is ever the one immense sun who, with the same life-giving and life-destroying rays, is working such different wonders. In like manner it is, with all natural sciences, the evolution theory which is producing the different conceptions of Nature. Every one is anxious to comprehend the true sequence of phenomena. All stand firmly on the impregnable basis of the "principle of sufficient reason," which states that every change must be preceded by a change and be followed by another. But when we ask, Which was the first, which the following? difference of opinion will arise: Is an animal, which has little capability, endowed with a simple organism, because it has as yet not been differentiated, or because it has retrograded in its descent from more highly developed beings? Such questions sometimes are extremely difficult to answer, and in these cases it devolves upon physiology to decide or at least to pronounce its weighty judgments. For whenever an organ retrogrades, function has disappeared much sooner than the rudimentary organ; but when, on the other hand, an organ is continuing to develop, function has appeared much sooner than the perfected organ. It would then have to be ascertained whether the organ in question is still possessed of a function, or has already lost it. If, for example, a perfected eye shows little or no sensitiveness to light, it must be in a state of retrogression; if it is very imperfect, and yet extremely sensitive to light, it is developing, while an eye of very simple structure which is not sensitive to light can only have become so through retrogression.

Embryonic eyes, of course, are in a state of progressive but individual development, while here we are only speaking of phyletic evolution. The inorganic sciences have similar questions to answer, though with them the conception of sensitiveness to light has a different meaning, and merely signifies receptibility, the capability of as-

similation or of disintegration, without an admixture of feeling and sensitiveness in a physiological sense. But, to continue the illustration, the mere question whether decomposition through light is less felt by the bromide of silver of a photographic plate than by the protoplasm in the leaves of a tree which derive their green color from that light—this question is embarrassing to those who assign to animals alone the sense of feeling, for, since the highly excitable protoplasm of nerveless animals is likewise sensitive to light, and not to be distinguished from that of many plants, they must decide whether the former specifically differs from the latter, or whether both are equally incapable of feeling. In the former case they are called upon to point out the specific difference, which they can not do; in the other they must state where, proceeding from the lower to the higher organisms in the chain of animal creation, the inability of feeling ceases and the sense of feeling begins, which is equally impossible.

Thus, it is in accordance with facts to assume that there is no well-developed dividing line between beings capable and incapable of feeling, but that all matter is endowed with a certain *sense of feeling*, which, however, only with a definite and an extremely complex arrangement and vibration of the molecules will develop into *feeling*. The simple bodies, the dead elements, therefore, although partly very easily changed through slight influences, are, in spite of their dim sense of feeling, not able to feel perceptibly, but as soon as they become part of the ganglionic cell of the brain, or only of the living protoplasm (through assimilation of food), they, combined with others, will by indescribably complex vibrations cause feeling to arise like lightning whenever an impression is made on them.

Every physiological explanation must, above all, be in perfect accord with morphological, mechanical, and chemical facts; on that all physiologists lay the greatest stress, but I do not understand why, regardless of physiological facts, morphologists, physicists, and chemists should be allowed to declare their explanations and principles to be the only true ones, or even the only possible ones. It has been demonstrated that matter must have other fundamental properties besides those ascribed to it by physicists and chemists. The axiom of mechanics, "Matter is dead!" will soon become obsolete, since a sense of feeling is inherent in all matter. This supposition does not make the least alteration in the imposing structure of the physical and chemical sciences, because in their formulas the new factor is merely an infinitesimal quantity in proportion to the rest; but the imperceptible is not the less real than the perceptible, because of its imperceptibility.

No one can hear a single leaflet tremble in the wind, but during a storm the roaring of the forest, caused by many leaves rustling together, may reach awe-inspiring power. Similarly, each molecule of matter may feel imperceptibly little when vibrating by itself, while,

together with many particles feeling likewise imperceptibly, it may co-operate in manifesting feeling, which, like lightning, arises and vanishes.

Through this conception, through acknowledging evolution and the sense of feeling, the whole of Nature may be brought in harmonious connection.

## TURPENTINE-FARMING.

By L. W. ROBARTS.

FINDING myself in the pine-region of Southeast Georgia, and thinking that some information on the subject above named may not prove uninteresting to your readers, I will endeavor to tell to them that which has been imparted to me by those thoroughly conversant with the whole business.

A turpentine-farm consists of from five to forty crops of ten thousand five hundred boxes each. The work is sometimes carried on by the owners of the pine-forests themselves; again, the trees are leased out for a certain number of years, two or three being about the limit. Negro labor is principally employed in this section. The work commences in November, when the boxing of the trees begins. The boxes, which are cut sloping back into the trees about a foot from the ground, measure three inches back at bottom, four deep, and about seventeen in length. In March they are cornered; that is, a chip is taken off on both sides just above the ends of the boxes. Next the faces for dripping are cut V-shape between and above the places chipped. The number of faces on each tree depends upon its size, varying from one to three. Besides the original cutting of the faces, the trees are hacked once a week during the dripping-season with a peculiarly shaped knife suited to the purpose. The hacking increases the length of the faces, as one or two inches of bark are taken off above each time.

The dipping of the crude into barrels begins about the middle of March, and the boxes are emptied seven or eight times during the season. They hold from one to two quarts each, and from 10,000 boxes 210 barrels is considered a fair, 250 a fine yield. The first year's dripping is called "virgin," the second "yearling," and all after "old stuff." From eight barrels of crude they get two of spirits of turpentine, and five to five and a half of resin. Of the latter there are several grades: W. W., "water-white"; W. G., "window-glass"; M, next highest, and so on up the alphabet, but down in quality, to A, the letter J being omitted. The first drippings, if not scorched in boiling, make beautifully white, transparent resin; hence the name "water-white." The crude prbducing this can never be obtained from the trees after the first month's running; that for W. G., "window-glass," possibly, into July or August.

Sometimes dealers are imposed upon by agents, who, by a skillful handling of the brush, can change W. G. into W. W., and H. into K., and so pass the resin off for a higher grade than it really is.

The stilling begins about April. One pleasant afternoon, a few weeks since, one or two friends and myself strolled down to a still, about a mile distant from the farm-house. The stiller and his wife were most kind, and cheerfully answered my many questions. The still, which cost about six hundred dollars, was a rude structure of two stories, or rather a ground-floor with one story, roofed, but not closed in. Ascending the rough stairway, we reached the top of the huge caldron, into which are poured from eight to ten barrels of crude at a charge. The opening, only sufficiently large to admit of the turning of a barrel of crude over it when the boiler was being filled, was covered by a copper cap that, being lengthened out, formed a short pipe which, bending downward, united with the spiral pipe or "worm" that coiled itself in the huge still-tub of water near by. The water was conducted into this tub by a trough leading from a well, the buckets of which were drawn several feet above the mouth of the well to a convenient height. A pipe from a barrel of water led into the boiler, so that the water could be turned in whenever, in the judgment of the stiller, it was necessary. When the boiling began, the vapor, rising and entering the "worm," was condensed by the cold of the tub into water and spirits of turpentine, which poured out into a barrel on the ground-floor. From this barrel the turpentine only was conducted into another; this was easily accomplished by having the connecting-tube placed near the top of the barrel, higher than the water ever reached, the turpentine always rising to the top: this was prettily shown by the stillers catching from time to time a tumblerful and holding it up, when it could be seen that the separation was instantaneous. The stiller frequently places his ear at the end of the "worm," as by the sound from the boiler he can judge as to the expediency of adding water to the crude. The proportion of spirits to water that flows out should be as two to three; the quantity of the former of course decreases as the time for letting off the charge approaches, and it at last should stand only a half-inch on a glass of water. But when the demand for resin is greater than that for turpentine, the tendency is not to carry the boiling quite so far, as more turpentine may be left to the improvement of the resin; still, it should be taken out sufficiently to prevent the softening of the one and a half inch sample-cube, which is placed in the show-case of the merchant.

When, during the boiling, the necessary proportion of spirits to water for discharging is reached, the stiller removes the cap, lessens the heat—as there is great danger of scorching the resin—and, after giving the contents of the boiler a vigorous stirring, lets it out at the opening near the bottom, a boiling tide, into the three strainers placed one above another upon the ground-floor, through which it passes to

the tank below. The upper strainer is of coarse wire, in which are caught the pieces of bark and other foreign substances that have escaped the wire skimmers when in the boiler; strainer No. 2 is of finer wire; No. 3 coarse, but covered with cotton-batting. When this mass of liquid has passed entirely through, the strainers are removed, and the still intensely hot resin is taken up by great dipperfuls and poured into barrels standing near. It must now be undisturbed until hard, as even putting a stick down into it injures the quality of the resin. The poorest crude, if taken off the furnace just at the right moment, gives W. W.; but if scorched the color is injured, and consequently the grade lowered.

The children around the still brought boxes containing flowers and brightly colored pictures, lying flat upon their bottoms, and the stiller poured a small quantity of the liquid resin upon them; this, continuing transparent, glazed them over and preserved the treasures. I still have a sprig of small leaves which he dipped for me that is coated over quite prettily. There are two or three discharges from the boiler each day.

All foreign matter taken from the crude, also the cotton-batting used in straining—in other words, the "dross"—although valuable as material for kindling, is frequently burned, as there is very little of it sent to market. I remember the dense smoke that caused the gentleman from the farm to hurry over to the still one afternoon, fearing that everything was being consumed, when it was only a bonfire of this most combustible material. In case of danger from fire to the still-house, the first step is to seal down the cap as rapidly as possible with mortar always kept mixed in a tub near by.

The resin is put in pine barrels; but oak barrels, made very tight, their seams being glued on the inside, are used for the turpentine. The uses of resin in the manufacture of soap, varnish, shellac, etc., and in various other ways, are numberless. The products of the turpentine-farms of this region are sent by steamer down the Altamaha to Doctortown, thence by rail to Savannah and Brunswick. Savannah is said to be the largest market for these commodities in the world.

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Mr. Bolton King maintained, in the British Association, that the future of successful agriculture lies in large farms under skilled management, with plenty of capital, or in co-operative farming. It can enjoy the economic advantages of large capitalist farms, and is believed to be competent to realize the social ideal sought for. Such evidence as is at hand is favorable to the feasibility of engaging the co-operation of the laborers in enterprises of this kind, and there is not likely to be difficulty in finding the required capital; but the chief obstacle to the extension of association farms lies in the scarcity of skilled managers, who will have to be waited for till they can be trained.

## RUSTIC SUPERSTITION.

THAT "the days of superstition are past" is an announcement frequently and triumphantly made by those who advocate the disestablishment or destruction of any institution or belief that happens not to be in accordance with their own interests or theories. Little, indeed, must such speakers know of the minds, not only of the poorer classes, but of those whose education, as one would suppose, should have raised them above the influence of the grosser and more vulgar forms of superstition. We are not now speaking of the newly invented astral bodies or telepathy; these are the latest refinements of spiritualism, and may die out; we refer to the fine old-fashioned belief in ghosts, witches, wizards, and "uncanniness," which is still far more prevalent than even the believers themselves realize, they being usually more or less ashamed of and reticent as to the faith that is in them.

Mr. Hardy, who has an unusual knowledge of rustic life and habits of thought, in a recent novel, "The Mayor of Casterbridge," gave a wonderful sketch of a local soothsayer, his patrons, and his profits; and though the date of the story lies as far as some fifty or more years behind us, there can be little doubt that the sorcerers of whom "Wide-oh" is the type still flourish in our midst. To this fact the daily papers bear witness, since we often read of some wretched old woman being haled before the bench, and sentenced to fine or a term of imprisonment for pretending to tell the fortunes of servant-girls with a pack of dirty cards or the dregs in a coffee-cup, though, by-the-way, there is considerable inconsistency in a legislation which punishes the old woman and yet permits turf-touters to advertise with impunity that they have the winner of the next three Derbies in their pockets, and are willing to part with the information on the transference of a certain number of half-crowns from those of a credulous public. Still, though the wise woman, usually a denizen of cities, is occasionally caught napping, owing perhaps to an infelicitous habit of mixing up magic with the reception of stolen goods, the wise man of the provinces is more wide-awake and carries on his trade without interference from the police, his specialty being the cure of warts, toothache, and certain cattle-diseases by incantation or other mystic rites.

We happened not long ago to meet a young, well-to-do, and well-educated farmer in a market town not on a market day, and in the course of conversation casually asked what particular business he had on hand. "A very bad toothache," he replied. The next and natural question was to inquire if he had "been and had it out." Blushing to his eyes he said: "I dare say you'll think me very foolish, sir, but I've been to a wise man to have the pain charmed away. Folks say as he's

wonderful at that sort of thing, so I thought I might as well give him a trial." This announcement being received with the burst of laughter he evidently expected, he hastily added, "Believe it or not as you like, sir, as soon as he said something the pain went clean away, and I've been easy ever since." It was worse than useless to explain the well-known effect on the nerves, of a visit to any sort of dental operator, and the agriculturist wended his way to spread abroad the fame of his healer, and no doubt to suffer renewed agonies as soon as he got home. It may be added that under no circumstances will a countryman, if he can help it, have a tooth taken out by a regular practitioner—a baker, grocer, or blacksmith, with a local reputation of being "uncommon handy," is almost always resorted to for this extreme measure. It is but another form of provincial superstition.

The familiar occurrence of a mysterious ringing of bells by some occult agency is a never-failing source of awful joy to the country town or neighborhood to which this supposed supernatural manifestation is vouchsafed. The house thus favored is the constant center of thought, conversation, and pilgrimage; groups of true believers stand outside with upturned gaze, as though expecting to see the ghost appear out of one of the chimney-pots and address the audience from the roof, while those who are sufficiently in the intimacy of the terrified though flattered household to be admitted to the haunted dwelling, would not change places with Mr. Rider Haggard's heroes. And when the inevitable *dénoûment* comes, when the half-silly servant-girl or wholly mischievous boy has been accidentally discovered throwing a rolled-up stocking or cap at the bell, in the general disappointment and sense of injury which ensues, faith though shaken is not destroyed. A few steadfast ones gather together, and comfort each other with such sayings as "'Twas better to make believe as 'twas all nat'ral," "Folks don't like their housen to get a bad name," or "Don't tell I as any gell could have kept they bells ringing the night through"; and the lump of incredulity thus gradually releavened, the next announcement that the spirits are at work again finds acceptance ready as ever. It must be frankly admitted that churchyards have of late years fallen from their high estate in rural estimation as the recognized ghost's playground; not that a countryman would willingly linger within these precincts after nightfall, nor would he appoint such a tryst for his lady-love, but he no longer regards the burying-place with his former feeling of reverential fear. The reason of this change is not easy to discover, as it can hardly be attributed to intellectual enlightenment. Perhaps he has good grounds for his confidence. It may be that since the passing of Mr. Osborne Morgan's bill, the *manes* of the older and orthodoxically interred residents sulk in their sepulchres, holding themselves aloof from possible contact with new-comers "licensed to walk" under a Nonconformist ritual, and that these latter, out of respect to class prejudice, or from a feeling of diffidence unknown in a previous

existence, shrink from obtruding themselves on public notice. If, however, churchyards have somewhat abated their terrors, it is as aforesaid owing to no decay of superstition; for certain lonely lanes or portions of roads supposed to be more or less haunted are still only willingly traversed in company or by daylight. And the peculiarity of these places is that they seldom, if ever, are the "walk" of any definite specter. The rustic, if he will talk on the subject at all, will tell you that he "have heard tell there's summat," but what "Summat" is, having no idea on the subject, he will certainly not attempt to express one; meanwhile "Summat" gallantly holds his allotted territory, and causes the belated villager to commit various acts of trespass in order to avoid Tom Tidler's ground.

"Summat" unfortunately does not always choose to live out-of-doors, as a landlord may find to his cost. Old farmhouses not unfrequently have a chamber set apart for the residence of this vaguest of phantoms; and as the growing-up family requires more room, the tenant will ask for partitions or fresh building rather than disturb "Summat" in his dusty though inhabitable apartment. A little way up the glen of Rothes, in Morayshire, is a large hillock, locally known as the "Doonie." A few years ago, and probably to this day, it had the reputation of being no canny after dusk. A Scotch "Summat" graced it with his presence, though in this particular instance he was probably originally inducted by illicit distillers, who sought his protection against disturbance in their business.

The old conventionally haunted family mansion, though fairly holding its own among the tenets of rustic superstition, does not—inasmuch as it is not open to the public—greatly exercise the rustic mind. The White Lady appears only on special occasions, the wheels of the invisible carriage rumble up only to that one door, and in neither case does the phenomenon bode evil to aught but the lawful proprietors of the ghost, though it is a drawback to service which has to be duly considered in the domestics' wages. Yet is there a country house we wot of in the west, where the atmosphere was so full of supernatural electricity, and so light a friction was necessary to secure its discharge, that the place acquired a local celebrity as inconvenient to the owner—who was non-resident, and wanted to find a tenant—as it was interesting to the neighborhood. In this case the disturbing agents were a skull and a couple of thigh-bones, said to have been the property of an ancestor who had been either hanged or murdered, both of which incidents had embellished the chronicles of a lively and aggressive race. Whether these relics had been collected from the gallows, or kept *in memoriam* of a coroner's inquest and a post-mortem examination, deponent sayeth not, nor is it known why they had been denied the rights of burial; but from some misplaced sentiment they were preserved, irreverently stowed in the cupboard of an attic, and there left to disturb the peace of the inmates, the specialty of these bones being, that if

untouched they were as well-behaved remnants of mortality as could be desired, but if meddled with, and the cupboard seems to have been always unlocked, they instantly resented the affront with knockings, rustlings, banging of doors, steps on the staircase, and other manifestations of outraged spirits. All this was alarming enough, and there was for a long time considerable difficulty in finding a care-taker, the simple expedient of burying the bones or of locking them securely away never apparently having occurred to any one. At last an old family gamekeeper (whom it was supposed the family ghost might tolerate), with his wife and a mischievous boy of about ten, were installed in charge. Gamekeepers are not as a rule much troubled with nerves. Familiarity in this instance, as in most others, bred contempt, till in a year or two the only notice the old man took of a violent outbreak on the part of his spiritual associates was to remark, "*There's that dratted boy been a-playing wi' they bones again*," as if the youth were surreptitiously preparing to join an Ethiopian troupe!

Rain seldom fails us in England, and very rarely do we suffer from anything approaching to drought. The ordinary wells, pits, and springs suffice for the farmers' needs, and they can dispense with resort to magic arts in search of water. Yet in the provinces would a man be deemed worse than profane who should express doubt in the virtue of the divining-rod. It is true that search for hidden treasure is not as general a pursuit as it was before the days of the rural police; but when Dousterswivel makes his appearance, as he still does from time to time in quiet country towns, he can reckon upon many believers and a fair supply of victims.

Can we fail to join "Wide-oh"—Mr. Hardy's rural wizard—in his astonishment "that men could profess so little and believe so much at his house, when at church they professed so much and believed so little"?—*Saturday Review.*

## SKETCH OF LEO LESQUEREUX.

By L. R. McCABE.

AMERICAN science owes an incalculable debt to the Geneva Revolutionary Council of 1848, that suppressed the Academy of Neufchâtel and sent to our shores Agassiz, Guyot, and Lesquereux. In the heart of Switzerland's mountain grandeur this illustrious trio first saw the light and drank of that love of Nature which, deepening with the years, peculiarly linked their lives. Agassiz had been in America two years, when he was joined by Guyot and Lesquereux, whose friendship had been formed while they were collaborators in the quaint Swiss town. Humboldt and Cuvier had showered their encomiums upon the great naturalist, and Continental Europe was heralding his praises, when the political changes of his native

land brought him to the New World, where he became the leading mind in zoölogy, as Guyot was in physical geography, and Lesquereux in paleontological botany. The two former, full of years and rich in truths bequeathed to science, have passed away; while the latter, bearing lightly his fourscore years, still works actively in bryological and paleontological studies at his home in Columbus, Ohio.

It was a bright morning in early June when the writer called at the house of Dr. Lesquereux. A few moments of waiting in the parlor were followed by the entrance of a middle-sized man with dark eyes that flashed with mirthfulness when he spoke, and a step so brisk, and hair and beard so free from time-strokes, that the long-cherished patriarchal vision of the botanist's appearance vanished.

"I am happy to make your acquaintance," said the colleague of Agassiz and Guyot, in English, melodious with the accent of France. "My son told me you were coming to see me," he continued, shaking my hand cordially. "Do you speak French? No? So, so. With my bad English and bad hearing"—he smiled, and pressed those ears that had been dead to sound for more than half a century—"I fear we can not carry on a satisfactory conversation," he said, as we drew our chairs to the open window. Then, with glowing eyes and a winning smile on his kindly old face, in response to written queries he modestly told the story of his life.

Leo Lesquereux was born at Fleurier, Neufchâtel, November 18, 1806. His immediate ancestors were French Huguenots. His father was a manufacturer of watch-springs, and, as was the custom of the country, wished his son to follow the same trade. The future botanist's health being delicate, however, his mother desired him to study for the ministry. But the grandeur of his mountain home had already sunk deep into the impressible soul of the youth, and circumstances sealed his preference for another pursuit. Under royal patronage the Academy of Neufchâtel enjoyed special advantages. When the young Swiss crossed its threshold he met in the enthusiastic Guyot a congenial companion. "Guyot and I," said Lesquereux, "were for some years brothers in study, working in common, and often spending our vacations together, either at Guyot's home at Hauterieve or with my parents at Fleurier, and I owe much in life to the good influence of this friendship." When Lesquereux had completed the Academy course he went to Weimar to perfect himself in the German language, preparatory to entering the university at Berlin. To defray his expenses here, he taught French in a young ladies' academy. "They were the happiest days of my life," he said. "My pupils were from the noble families of Weimar. They were well educated, and came to me for conversation. I remained at Weimar for some time. Then love came, and I went back to Switzerland, and I *never* regretted it."

It was at Weimar that the botanist met the young woman who became his wife. She was of humble fortune but of noble family, and

in early childhood enjoyed the friendship of Goethe. Her father was a man of learning, with a strong propensity to science. When the young man was about to return to his home, the father, who was setting out in the same direction, invited him to share his carriage. The marriage was agreed upon during this journey. Lesquereux brought his bride to Fleurier, where, in sight of the lofty Alpine peaks, he became engaged in the study of mosses, and later of fossil botany. It was at this period that he became interested in peat, its formation and possible reproduction. The protection of the peat-bogs, the principal fuel of Switzerland, was then a matter of great importance to the Government of Neufchâtel. Lesquereux published some memoirs of his investigations, which attracted the attention of Agassiz, then occupying the chair of Natural History in the Academy of Neufchâtel. He invited the author to visit him for a consultation upon the theories he had set forth. Shortly after this visit—which started a friendship that ceased only with Agassiz's death—the Government of Neufchâtel offered a gold medal for the best popular treatise on the formation and reproduction of peat.

A committee of eight *savants* was appointed to explore the peat deposits of the state, in order to be fully informed of the value of Lesquereux's researches. Professor Agassiz, who was a member of the committee, at first did not agree with his theory, but after the committee had been out a few days—they were two weeks on the field—he accepted it, and became its ardent supporter. "During these days, passed in constant intercourse with the great Agassiz," said Lesquereux, "I became sincerely attached to him; not only on account of his great mind and disposition to consider any subject fully, but because of his goodness of heart, the charm of his conversation, his childlike simplicity, and clearness of thought and expression, even in discussing the most abstruse subjects of science." Lesquereux's memoir was awarded the prize, and gained wide reputation; and it is still quoted as one of the best authorities on the subject. The author, under the patronage of the King of Prussia, subsequently explored the peat-bogs of Northern Europe. In this manner he became master of the botany, physics, chemistry, and geology of those districts, and was led to think that the theory he had formulated might be applied to the coal-seams of our country. To the New World his labors were now transferred, in 1848, when, having become totally deaf in the prime of life, he also found himself deprived of scientific employment at home by the political changes that followed the revolution. It was at this crisis that he came to Boston, where, at the earnest solicitation of that naturalist, he became a member of the household of Agassiz. Here he worked upon the botanical part of Agassiz's "Journey to Lake Superior," until the eve of Christmas, 1848, when, at the invitation of the eminent bryologist, W. S. Sullivant, he went to Columbus, Ohio, and, entering his laboratory, continued there the study of mosses. At

the close of the year 1849, under the advice and with the co-operation of Mr. Sullivant, he made a tour of exploration among the mountains of the Southern States, for the collection of plant-specimens, and secured a great variety of plants, which found a ready sale among scientific students. He was particularly successful in the collection of mosses. The preparation of the specimens, their determination and distribution, gave him employment for two years, and resulted in one of the most valuable contributions to American bryology—the "Musci Americani Exsiccati," by W. S. Sullivant and L. Lesquereux. The expense of preparation and publication of this work was defrayed by Mr. Sullivant, who allowed his colleague the benefit of the sales. Using that author's library and herbarium—now the property of Harvard College—for their common studies, Lesquereux lent most valuable assistance to the preparation of Mr. Sullivant's works on the mosses of the Wilkes' South Pacific Exploring Expedition, Whipple's Pacific Railroad Exploration, and the "Icones Muscorum." The publication of Brongniart's "Prodrome," and the commencement of the "Histoire des Végétaux Fossils," in 1828, laid the solid basis upon which the science of paleobotany has been erected. Lesquereux began to write in 1845, and his studies in America have been directed especially in the line of fossil botany. His most valuable researches, beginning in 1850, lay in the study of the coal formations of Ohio, Pennsylvania, Illinois, Kentucky, and Arkansas, and his reports appear in the geological surveys of all these States. Particularly important are his studies of the coal flora of Pennsylvania, published in the report of H. D. Rogers in 1858, together with a "Catalogue of the Fossil Plants which have been named or described from the Coal-Measures of North America." Lesquereux also worked up the coal flora in the second geological survey of Pennsylvania. The fruit of this labor was two volumes of text and an atlas, published in 1880—the most important work on carboniferous plants that has been produced in America. Geological work, especially researches on fossil botany, in connection with the United States Geological Surveys of the Territories, began in 1868 to absorb his attention. He was employed to work up the collections of Dr. F. V. Hayden's surveys of the Territories, and important papers on the subject appeared in the annual reports of the surveys from 1870 to 1874 inclusive. Lesquereux was frequently called to Cambridge to determine the specimens of fossil plants in Professor Agassiz's museum, where he was a guest in the naturalist's household for weeks and months at a time, and his attachment to him grew very strong.

Lesquereux, during his long and industrious life, has contributed twelve important works to the natural history of North America, besides a large number of memoirs on divers subjects, amounting in all to about fifty publications. He is a member or correspondent of more than twenty scientific societies of Europe and America, and was the first elected member of the National Academy of Sciences. The

characteristic works of the most eminent scientific writers of the age comprise his library: Brongniart, who laid the foundation of paleobotany; Göppert, who built its superstructure; Schimper, Heer, Dawson, Ettingshausen, Newberry, the Marquis Gaston de Saporta, together with Grande Eury and Renault, who thoroughly studied the carboniferous flora of France; Williamson, who mastered that of England; Nathorst, who opened up the subterranean floral treasures of Sweden; Engelhardt, Hosius, Under Marck and Schenk, who investigated without exhausting the rich plant-beds of Germany—all are numbered among Lesquereux's friends and correspondents.

The fraternal bond that binds the scientific world is almost indissoluble. When asked if his long and intimate associations with so many illustrious minds had not stored his memory with anecdote and reminiscence, Lesquereux responded: "The science-students' life is absorbed with grave and serious truths; they are naturally serious men. My associations have been almost entirely of a scientific nature. My deafness cut me off from everything that lay outside of science. I have lived with Nature, the rocks, the trees, the flowers. They know em, I know them. All outside are dead to me."

*List of Works and Memoirs published by Professor Leo Lesquereux.*

1. Catalogue of the Mosses of Switzerland and Mennirs. Natural History Society. Neufchâtel, 1840.
2. Explorations of Peat-Bogs. Received gold medal prize from the Government of Neufchâtel.
3. Directions for the Exploration of Peat-Bogs. 1844.
4. Letters written on Germany. 1846.
5. Letters written on America. 1849–1855.
6. Botany of Agassiz's Lake Superior. 1848.
7. New Species of Fossil Plants. Boston Journal of Natural History. 1854.
8. Paleontological Report. Pennsylvania Geological Report. 1857.
9. Paleontological Report. Kentucky Geological Report, vol. iii. 1857.
10. Paleontological Report. Kentucky Geological Report, vol. iv. 1861.
11. Catalogue of the Fossil Plants of the Coal-Measures of Pennsylvania. 1858.
12. Paleontological and Botanical Report. Arkansas Geological Report. 1860.
13. Paleontological and Geological Report of Indiana. 1862.
14. Paleontological Report of Illinois. Worthen's Geological Report, vol. ii. 1866.
15. Paleontological Report of Illinois. Worthen's Geological Report, vol. iv. 1870.
16. Catalogue of California Mosses. Transactions of American Philosophical Society, vol. xiii. 1864.
17. On Tertiary Fossil Plants of Mississippi. Transactions of American Philosophical Society, vol. xiii. 1864.
16. On Fucoids in the Coal. Transactions of American Philosophical Society, vol. xiii. 1864.
17. On Pacific Coast Mosses in California. Academy of Sciences. 1868.
18. Musci Exsiccati, first edition. In association with W. S. Sullivant. 1856.
19. Musci Exsiccati, second edition. 1865.

22. Report to Hayden. United States Geological and Geographical Survey of the Territories. 1870.
23–26. Report to Hayden. 1871–1873.
27. Monograph of the Cretaceous Flora of the Dakota Group. 1874.
28. Review of the Fossil Flora of North America. (Republished, with corrections, in the Penn Monthly.) 1875.
29. Article on Coal and Coal Flora. Encyclopædia of North America.
30. Text (Latin) of Sullivant's Supplement to the Icones. 1874.
31. On Some New Species of Fossil Plants, Tertiary. Bulletin 52, second series of Hayden. 1875.
On Some New Species of Fossil Plants, Cretaceous. 1875.
32. Report on the Cretaceous and Tertiary Floras of the Western Territories. Hayden's Report, and separate copies. 1874.
33. Species of Fossil Marine Plants found in the Carboniferous Measures. Geological Survey of Indiana, Seventh Annual Report. 1876.
34. Plants of the Silurian. Proceedings of the Philosophical Society of Philadelphia. 1877.
35. Contributions to the Fossil Flora of the Western Territories. United States Geological and Geographical Survey.
The Tertiary Flora. 1877.
36. Pliocene Flora of the Auriferous Gravel of California. Museum of Comparative Zoölogy, Cambridge. 1878.
37. Catalogue of the Fossil Plants of the Tertiary and of the Cretaceous. Hayden's Report. 1878.
38. On Cordaites. American Philosophical Society. 1878.
39. On a Branch of Cordaites bearing Fruit. American Philosophical Society. 1879.
40. The Coal Flora (Atlas). Second Pennsylvania Geological Survey. 1879–1884.
41. The Coal Flora (text). Three volumes. 1880–1884.
42. Manual of the American Mosses. With Collaboration of Thomas P. James. 1884.
43. Monography of the Cretaceous and Tertiary Flora of the United States. Geological and Geographical Survey of the Territories, vol. viii. 1883.
44. Principles of Palæozoic Botany. Geological Report of Indiana. 1884.
45. Vegetable Origin of Coal. Report of Geological Survey of Pennsylvania. 1885.
46. Divers Questions concerning Coal. Silliman's Journal. 1860.
On the Fossil Fruits of the Lignites of Brandon. 1861.
On Some Fossil Plants of the Recent Formations. 1859.
On Some Fossil Plants of John Evans. 1859.
On the Origin and Formation of the Prairies. 1865.
On the Formation of Lignite Beds. 1874.
On Land Plants in the Lower Silurian. 1874.

# CORRESPONDENCE.

## MORE ABOUT THE "JOINT-SNAKE."

*Editor Popular Science Monthly:*

SIR: In the January number of the "Monthly" one of your correspondents enters the list as a champion of the *joint-snake tradition*, and adds the details of a personal encounter with the problematic ophidian. He informs us that he has preserved the memory of the very spot where he saw the disjointed fragments of the much-controverted reptile. It is a pity that he did not also preserve a few of those fragments. When the evidence of the controversy was sifted in the columns of "Home and Farm," a year ago, Professor C. H. Hunter, of Louisville, offered a liberal reward for a specimen *joint-snake*, or any two readjustable sections of that complex entity. Similar inducements have been repeatedly offered by Dr. Baird, by the editors of the "American Naturalist," by Professor McKnight, of St. Louis, Missouri, and by several patrons of the Smithsonian Institution. Yet the one *visible* link in the alleged chain of evidence is still missing. The museums of the civilized world do not yet boast a specimen of a joint-snake or any two reconstructible sections of its organism. One of the correspondents of "Home and Farm" suggested that people are naturally averse to handling reptiles, even of the more harmless varieties. They must be at least equally averse to handling the less harmless varieties, and such things as hairy, venomous spiders. Yet it would be no overestimate to say that the museums of the United States alone contain a thousand tarantulas, and at least twice as many rattlesnakes and "spreading adders." If we are to go by hearsay evidence, we would have to believe in vampires and fairies, as well as dragons and sea-serpents. The vampire-stories of the lower Danube have been confirmed by the testimony of a host of witnesses, many of them respectable persons of more than average intelligence. The same held doubtlessly good of the witchcraft-stories, accepted by the most enlightened jurists of the middle ages, on the detailed and positive testimony of eye-witnesses. A fair plurality of those witnesses may have intended nothing like willful misrepresentation. But the belief prevailed, and biased their faculties of observation, as well as their fancy. A direct refutation of hearsay evidence is, of course, impossible, and I hold that the burden of the proof rests exclusively with its defenders. Direct proofs we have none; the indirect proofs, i. e., the entire and persistent absence of all positive evidence, as well as the glaring anomaly of the alleged portent, point all the one way. In the present stage of the controversy an infinite preponderance of probability is therefore clearly against the exponents of the tradition.

Yours, very respectfully,
JAMES T. BECKER.

LUDLOW, KENTUCKY, *February* 3, 1887.

## AN EXPLANATION OF THE "JOINT-SNAKE."

*Editor Popular Science Monthly:*

SIR: Whatever some of your contributors may say to the contrary, there certainly is a reptile resembling a snake, inhabiting the western part of the United States, the tail of which flies to pieces on very slight provocation. It is not, however, a snake, as some of them suppose, but a limbless lizard of the genus *Ophisaurus*. I have seen hundreds of them in Kansas near Fort Riley and farther west, and have sent many specimens to the Academy of the Natural Sciences of Philadelphia and to the Smithsonian Institution in Washington. This lacertilian is a very beautiful animal, varying in length from ten to fourteen inches or more, and in diameter at its largest segment from three-fourths of an inch to an inch and a half. It is perfectly harmless, and when struck or captured sheds its tail sometimes in several pieces, each of which continues to wriggle for some time afterward. It is, perhaps, scarcely necessary to say that these several segments do not start out on voyages of discovery for each other in order to reunite with their parent. The animal has, however, the power of reproducing the lost part, as have other lizards. The name of "glass-snake" is that by which this reptile is popularly known. Glass-snakes are common in other parts of the world. The *Pseudopus Pallasii* is found in Hungary, Bulgaria, Turkey, and neighboring countries. In general appearance it resembles a snake. The fore-limbs are entirely absent, and the hind-limbs are rudimentary, as they are in certain true ophidia. Lizards without legs are also very abundant in Australia.

Other lizards, besides the glass-snakes, lose their tails with great ease, and some of them, like the geckos, throw off this appendage spontaneously as a means of protection, doubtless hoping thereby to create a diversion of the enemy toward the wriggling fragment, while the owner makes good its es-

cape. The *Ophisaurus ventralis* of Kansas and other Western States has no external limbs; there are, however, rudimentary hind-limbs under the skin, very similar in general appearance to those found in the black-snake (*Coluber constrictor*). Stories of the quivering fragments of its tail coming together again after being detached from the body were common enough among the soldiers and settlers, but I am able to state of my own knowledge (though it seems to be a waste of words to do so) that they are not endowed with sufficient perceptive and volitional power to accomplish such an act. They die in a few hours, and are reproduced by the animal in a few months. The *Ophisaurus* is perfectly harmless, and is readily tamed so as to become a pet.

WILLIAM A. HAMMOND.

NEW YORK, *March* 1, 1887.

## EDITOR'S TABLE.

### *SCIENCE AND STATESMANSHIP.*

IN the January number of the "Contemporary Review," Madame Adam has an article entitled "Science in Politics," the main contention of which appears to be that science and politics make a very bad mixture. The proof of this position she finds in the evil influence exerted, as she believes, by the late M. Paul Bert on contemporary French politics. M. Bert, she avers, was the ruin of Gambetta by turning him aside from a broad, sympathetic way of treating public questions into a narrow and abstract way of treating them. The *savant* applied himself to political questions in the same spirit in which he applied himself to questions of physiology; and was prepared to act upon the results obtained with as little hesitation as if it were a mere matter of carrying through some laboratory experiment. In fact, he was just as ready to vivisect the nation with a new school law as to vivisect a cat in the ordinary fashion. So runs the indictment against M. Bert; and because M. Bert, the scientist, was so rash an innovator in politics, we are asked to learn the lesson that the more science is kept out of politics the better. Well, Madame Adam is a very clever woman, and what she says about M. Bert may be all true; but we do not quite see our way to an acceptance of the conclusions she offers us. Science is something more than physiology: a man may be a good physiologist, and yet outside of his special study may have anything but a scientific mind. What is wanted for political action is science in its most comprehensive sense; and, other things being equal, the more of true science a statesman possesses, the better fitted, we fully believe, he will be for his position. The statesman, of course, needs to know men, and to know them, not as subjects for the operating-table, but as living, moving units of the social organism. But this knowledge properly co-ordinated is scientific knowledge. The scientific statesman is not swayed by every impulse of the hour; he knows something of human history; and he knows how short-lived many movements are, and how infallibly communities will in the long run obey the general laws of their evolution. At the same time he makes allowance for the strength of many feelings that perhaps he does not himself share. He may be very free from prejudice himself; but he knows how large and how necessary a part prejudice plays in human affairs, and makes allowances for it accordingly. To a man who had got beyond physiology and physiological methods the knowledge he had acquired of that science would often be of special value for the understanding of political problems. The problem of problems in politics is indeed to establish a sociological balance of functions analogous to that physiological balance which is measurably attained in the healthy human body. We want to avoid con-

gestion on the one hand and depletion on the other. We want neither over-nutrition nor innutrition. We want brain-direction, but we want spontaneous activity in local centers. We want a proper division of labor, a proper specialization of function. We want a stable equilibrium of society such as results from free contact with natural influences and conditions. To say that a knowledge of the normal and pathological conditions of the human body would be of no advantage—would be even a drawback—for the understanding of social phenomena and the guidance of social action, seems to us a most unreasonable position. We should say that it would be a great and signal advantage provided only—as we have already hinted—that the physiologist knew enough to recognize that social facts call for somewhat wider canons of interpretation than physiological ones.

But there is positively no science that will not bring its own quota of aid to statesmanship. Chemistry, with its definite laws of combination, its resemblances concealed under differences and differences concealed under resemblances, throws many a gleam of light on the phenomena of human action. So with physics, so even with mathematics. But when we speak of science aiding statesmanship, be it understood that we mean statesmanship, and not merely the art of the political manager. The statesman can afford to have a mind widened and enriched by every variety of knowledge. Why? Because it is his concern to know the truth about everything, in order that he may consult for the general good to the best possible advantage; because he wishes to mark out such lines for political activity as run parallel with those that Nature has traced in bringing man up to the political stage; because he wishes to build on Nature's foundations, and so help to establish a natural and durable order of things in the political world. The party manager, on the other hand, has nothing to do with these things: he wants to organize victory for his party, and for that purpose he only requires the aid of a very special science—the science of catching votes. At present there is not much science in our politics. Madame Adam need not tremble lest accomplished physiologists should disturb the American system with methods borrowed from the laboratory. We keep all such people at a safe distance, and pay honor only to the manipulator of the caucus and the primaries. But when politics comes to be recognized as the science of good government instead of as the science of *getting hold of the government*, the need for statesmanship will begin to be felt; and with the demand for statesmanship will come a recognition of the fact that the highest and widest knowledge can nowhere be more profitably or honorably employed than in the service of the community.

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### *THE GROWTH OF INDUSTRIALISM.*

THREATENINGS of war continue to reach us from abroad, and appear to grow more serious with each succeeding repetition. They are often accompanied, it is true, by expressions of a desire for peace, emanating in some cases from those highest in authority; but these seem to be little more than the shallowest pretense, for they are belied by the systematic and unremitting preparations for conflict so generally apparent. Yet these very preparations are in turn impudently justified as tending to the preservation of peace and good-will. Taking advantage of the excitement and solicitude that the prospect of a great European war is calculated to arouse, the spendthrift politicians of our own country are vigorously urging their schemes for the multiplication and improvement of our coast defenses and the increase of our naval armament. These measures are

also claimed to be in the interest of peace, when, in reality, if carried into effect, their immediate result will be an enormous expenditure of public money, and afterward their presence will be more likely to provoke than to avert a collision. The nation equipped for war is like the bully with his revolver—always ready for a row, and not likely to miss the chance when an opportunity occurs.

Unfortunately, there seems to be enough of this belligerent and barbarous spirit left, especially in the Old World, to keep up a constant turmoil, or at least to maintain a state of perpetual apprehension, which tends to exert a paralyzing effect upon all forms of industrial effort. But, bad as the outlook at present appears, there is much cause for satisfaction on the part of the friends of industrialism in the growth and extension, under the favoring influence of science, of the arts which make for peace and right living; and it is not a little encouraging that there is already apparent a decided tendency to abandon the strifes of war, and adopt in their stead the more generous rivalries incident to a process of industrial development.

During the last quarter of a century a great impulse has been given in many states to manufacturing interests, the improvement and perfection of working methods, and the competition for excellence in industrial products; and, even in some of the nations whose warlike attitude has given alarm, the earnestness of the people in this direction is already comparable with and promises ultimately to suppress the belligerent disposition of their rulers. Thus it happens that the merchants of Germany are crowding the English out of the markets which they thought their permanent possession, by being able to offer to buyers more desirable bargains. The reason of this is that, while those who supposed they held a monopoly of these markets have been content to rest at a certain point of excellence in manufacture, or have even been careless about the matter, their rivals have persistently sought to improve the quality and the methods of production, and to adapt their goods to the exact taste of their customers; and, apace with this, have developed systems of thorough training, in general and special schools, of their artisan classes in all branches of manufacture, and in the numerous applications of science to the arts.

It is thus becoming recognized that excellence in technical industries and the special training of artisan youth are quite as important for the prosperity and security of the nation as a firm military position; and earnest efforts are making in this country and in England to put in operation means by which these may be attained. It has been proposed in England to honor the jubilee of the Queen's reign by founding an Imperial Institute, the purpose of which shall be to advance the knowledge and practical skill of the productive classes of the empire. The exact shape which the scheme shall assume has not yet been determined, and has hardly been conceived. Professor Hurley, who warmly commended it at a public meeting, would have in the Institute, as he has said in a note subsequently written, "something which should play the same part in regard to the advancement of industrial knowledge as has been played in regard to science and learning in general, in these realms, by the Royal Society and the universities." In his conception of the scheme as he commended it, he pictured the Imperial Institute to himself, he says—

> As a house of call for all those who are concerned in the advancement of industry; as a place in which the home-keeping industrial could find out all he wants to know about colonial industry and the colonist about home industry; as a sort of neutral ground in which the capitalist and the artisan would be equally welcome; as a center of intercommunication in which they might enter into friendly dis-

cussion of the problems at issue between them, and, perchance, arrive at a friendly solution of them.

I imagined it a place in which the fullest stores of industrial knowledge would be made accessible to the public; in which the higher questions of commerce and industry would be systematically studied and elucidated; and where, as in an industrial university, the whole technical education of the country might find its center and crown.

If I earnestly desire to see such an institution created, it is not because I think that or anything else will put an end to pauperism and want—as somebody has absurdly suggested—but because I believe it will supply a foundation for that scientific organization of our industries which the changed conditions of the times render indispensable to their prosperity.

I do not think I am far wrong in assuming that we are entering, indeed have already entered, upon the most serious struggle for existence to which this country has ever been committed. The latter years of the century promise to see us embarked in an industrial war of far more serious import than the military wars of its opening years. On the East, the most systematically instructed and best-informed people in Europe are our competitors; on the West, an energetic offshoot of our own stock, grown bigger than its parent, enters upon the struggle possessed of natural resources to which we can make no pretension and with every prospect of soon possessing that cheap labor by which they may be effectually utilized.

Many circumstances tend to justify the hope that we may hold our own if we are careful to "organize victory." But, to those who reflect seriously on the prospects of the population of Lancashire and Yorkshire—should the time ever arrive when the goods which are produced by their labor and their skill are to be had cheaper elsewhere—to those who remember the cotton famine, and reflect how much worse a customer famine would be, the situation appears very grave.

Such an institution as Professor Huxley here outlines, founded under the auspices which surround this enterprise, would undoubtedly give an immense impetus to efforts for the elevation of industrial art; and its establishment, if effected, will mark an epoch in the history of the practical applications of science.

# LITERARY NOTICES.

THE GEOGRAPHICAL AND GEOLOGICAL DISTRIBUTION OF ANIMALS. By Professor ANGELO HEILPRIN. "International Scientific Series." Vol. LVII. D. Appleton & Co. Pp. 435. Price, $2.

THIS volume sustains the high character of the International Scientific Series, and is a timely one, as the need of a compact work on this fascinating study has long been recognized. Wallace's larger work, in two volumes, while graphic in its method and full of interesting reading, is somewhat antiquated in its classification, a fault from which this book is not quite free.

The reader will find brought together a remarkable array of facts from various authors bearing upon the many questions involved in the subject. A vivid sketch is given of the apparently startling contradictions in the distribution of animals, the well-known case of faunal separation between the Islands of Bali and Lombok being cited among others. The author then says: "Mysterious as these various phenomena of distribution may appear, they yet have all their logical explanation. A quarter of a century ago, when the doctrine of independent creation still held sway over the minds of most naturalists, and when the organic universe was reflected in the eye of the investigator as an incongruous agglomeration of disjointed parts, there was, indeed, no necessity for specially accounting for the facts, since they were conceived to be such by reason of a previous ordination. Now, however, when the full value of the evolutionary process is recognized, and animate nature has come to be looked upon as a concrete whole, bearing special relations to its numberless parts, each individual fact seeks its own explanation, which explanation must of necessity stand in direct harmony with some previously observed fact. When, therefore, we seek to unravel the tangle of zoögeography and to harmonize its apparent incongruities, we must at the outset admit that distribution, such as it is, is the outcome of definite interacting laws—laws which stand in relation to each other as absolutely as they do in any other field of action—and not a hap-hazard disposition, as some would lead us to suppose, setting all inquiry at defiance."

Among the many subjects treated of are relations of past faunas; origination of faunas; areas of specific, generic, family, and ordinal distribution; conditions effecting distribution; migrations of animals; dispersions; zoölogical regions accompanied by a colored outline-map; distribution of marine life; nature of marine faunas, such as deep-sea, oceanic, pelagic, littoral; succession of life; faunas of different geological periods; appearance and disappearance of species, reappearance, extinction, and other subjects dealt with from geological evidence. Here the author enters into interesting discussions in regard to possible reappearance of species, quoting opinions and statements from various authors, and leaning somewhat as to the possibility of a species evolving again from the parent or parallel stock. In reading these pages, one is more fully convinced than ever that such apparently inexplicable occurences of identical species in beds widely removed vertically are more rationally explained by the assumption of the very great imperfection of the geological record. As an evidence of this, consider the fact that over two hundred thousand species of insects have been described as living to-day. Now this class of creatures has been in existence since the Devonian, and probably as numerous in species since the Mesozoic as at the present day, and yet the number of fossil insects described from every geological horizon to the present would not exceed in number the species of the smallest order living at present. A species of Lingula, which is found in a few localities on the southern coast of the United States, if fossilized would very closely resemble certain forms in the Silurian. One might scan the Tertiary beds in the Southern States without finding a trace of this species, and yet an elevation of the coast-line of North Carolina might show this ancient worm in great numbers when the deposits below reveal no trace of it. This might appear to a future geologist like a re-evolution of this species, whereas, judging from what we know of the geographical limitations of certain groups, it can only be interpreted as the preservation of colonies under favorable conditions.

Globigerina still survives, because the abysses of the deep sea probably remain in the same physical conditions as regards temperature, pressure, light, etc., as they did in the Cretaceous, and thus we have this creature and other cretaceous forms persisting to the present day.

We can heartily commend this book as a convenient and compact treatise on a great and voluminous subject.

PHYSIOLOGICAL BOTANY. An Abridgment of the Student's Guide to Structural Morphological and Physiological Botany. By ROBERT BENTLEY, F. L. S. Prepared as a sequel to "DESCRIPTIVE BOTANY," by ELIZA A. YOUMANS, author of "First Book of Botany," editor of "Henslow's Botanical Charts." New York: D. Appleton & Co. 1887. Pp. 292. Price, $1.40.

THE author of this work, Dr. Robert Bentley, is an eminent English botanist, who has had more than thirty years of practical experience as a teacher, and whose various text-books hold a first place in his own country. The present treatise is a model of clear, concise, and accurate statement, giving a complete popular view of the minute structures, the functions, and the development of the various organs of plants. Great pains have been taken by Professor Bentley to bring the different subjects treated of down to the present state of science, and much care has evidently been exercised in condensing the numerous details in each department and arranging them in the best manner for the pupil.

As physiological botany is the same in every part of the globe, and might exist in its fullness if there were only one species of plant in existence, the fact that this work is by an English author has no bearing upon its use in this country. The "Descriptive Botany," with its contained Flora, published two years ago in this series, and to which this is a sequel, covers all that portion of botanical science which has local bearings. In the introduction to that work, after explaining and enforcing the reasons for an early beginning of the study of plants by direct observation, it is recognized that physiological botany may be pursued with profit by ordinary school methods, and the publication of the present manual was accordingly promised; and it completes the exposition of botanical science in Appletons' series of science text-books.

THE ORIGIN OF THE FITTEST. ESSAYS ON EVOLUTION. By E. D. COPE. New York: D. Appleton & Co. Pp. 467.

THIS volume includes twenty-one essays which represent the reflections that suggested themselves to the author while he was engaged in special zoölogical and paleontological studies. These studies related particularly to the vertebrates, but they impressed the conviction that the conclusions derived from them were also applicable to invertebrate animals and plants. The law of natural selection of Wallace and Darwin is regarded by Professor Cope as only restrictive, directive, conservative, or destructive of something already created. It includes no active or progressive principle, but "must first wait for the development of variation, and then, after securing the survival of the best, wait again for the best to project its own variations for selection. In the question as to whether the latter are any better or worse than the characters of the parent, natural selection in no wise concerns itself." The expression, "survival of the fittest," with which Spencer epitomized this law, is pronounced "neat," and "no doubt covers the case, but it leaves the origin of the fittest entirely untouched." It is proposed, then, to seek for the originative laws by which the materials whence the selection is made are furnished—"in other words, for the causes of the origin of the fittest." The laws which have regulated the successive creations, as the author attempts to define them in his essay on the "Origin of Genera," appear to him to have been of two kinds: the first, that which has impelled matter to produce numberless ultimate types from common origins; and, second, that which expresses the mode or manner in which this first law has executed its course, from its beginning to its determined end. The origin of genera is assumed to be a more distinct subject from the origin of species than has been supposed. A descent with modification involves continuous series of organic types through one or many geologic ages, and the coexistence of such parts of such various series at one time as the law of mutual adaptation may permit. These series, as now found, are of two kinds—the uninterrupted line of specific, and the same uninterrupted line of generic characters. These are independent of each other, and have, as it appears to the author, been developed *pari passu*, so that he conceives it "highly probable that the same specific form has existed through a succession of genera, and perhaps in different epochs of geologic time"; or, as it is otherwise expressed, species may be transferred from one genus to another without losing their specific characters, and genera from one order to another without losing their generic characters." These explanations may help to make more clear the bearing of what may be regarded as the leading doctrines of Professor Cope's theory, which are, in brief, that the development of new characters has been accomplished by an acceleration or retardation in the growth of the parts changed; that an exact parallelism exists between the adult of one individual or set of individuals, and a transitional stage of one or more other individuals—to be distinguished from the inexact parallelism of Von Baer, a law which expresses the origin of genera and higher groups because they can only be distinguished by single characters when all their representatives come to be known (that is, that upon a view of all the individuals the transitional differences are so gradual that hard and fast lines of distinction are obliterated); that genera and various other groups have descended, not from a single generalized genus, etc., of the same group, but from corresponding genera of one or more other groups—the doctrine of homologous groups; and that these homologous groups belong to different geological periods and different geographical areas, and are related to each other in a successional way like the epochs of geological time. To these are added the law of repetitive action, by which the structures of animals are shown to have originated from simple repetitions of identical elements; and the existence of a special force exhibiting itself in the growth of organic beings, called growth-force, or bathmism, the location of which at certain parts of the organism, indicating abstraction from other points, determines the direction of development. The location of the growth-force is accomplished by use or effort,

which is exerted so as to modify the environment, and is modified by it. The location of this energy, to produce the change of evolution, is due to an influence called "grade-influence," which is, further, an expression of the intelligence of the animal, adapting its possessor to the environment by an "intelligent selection." Inheritance is a transmission of this form of energy. The part performed by intelligence in evolution is correlated with the fact deduced from the observation of the birds and mammals, that all animals are educated by "the logic of events," that their intelligence, impressed by changed circumstances, can accommodate itself more or less to them, and that there is nothing in this part of their being opposed to the principle of "descent with modification." The genus *homo*, according to the author's conclusions, "has been developed by the modification of some pre-existent genus. All his traits which are merely functional have, as a consequence, been produced during the process. Those traits which are not functional, but spiritual, are of course amenable to a different class of laws, which belong to the province of religion." The evolution of moral qualities may be related with the reproductive instinct, from which the social affections are developed. The struggle for existence among men ranges all the way from a rivalry of physical force to a rivalry for the possession of human esteem and affection. "The ultimate prosperity of the just, assured and foretold by prophets and poets, is but a forecast of the doctrine of the survival of the fittest. The unjust are sooner or later eliminated by men from their society, either by death, seclusion, or ostracism." But lines of men in whom the sympathetic and generous qualities predominate over the self-preservative, are doomed to extinction. Hence, evolution can produce no higher development of the race than an equivalency of these two classes of forces.

The matter of the volume is arranged in four parts, or series of essays: First, appear the papers on "General Evolution," in which the general principles of the author's theory are aid down or foreshadowed. Following this part come, s ccessively, papers on the "Structural Evidences of Evolution," on "Mechanical Evolution," and on "Metaphysical Evolution." In the concluding paper, the "Origin of the Will" is discussed.

OUR ARCTIC PROVINCE. ALASKA, AND THE SEAL ISLANDS. By HENRY W. ELLIOTT. New York: Charles Scribner's Sons. Pp. 465. Price, $4.50.

MR. ELLIOTT has given a most attractive volume, full of general and of scientific interest. The scientific matters are presented so as to be popular reading, and that which may be classed as of general interest is very far from not being of scientific merit and value. It is impossible to give, in an ordinary book notice, a summary of a work embodying so great a variety of matter; and we can not, perhaps, make a more comprehensive characterization of its contents than to say that it is devoted to the description and illustration of Alaska and all that pertains to it. First we have the history of the discovery of the country, its occupation by the Russians, and its transfer to the United States. This is followed by an account of the features of the Sitkan region, and a description of the aboriginal life of the Sitkans. Accounts are given of "The Alpine Zone of Mount St. Elias," with its superb and lofty peaks seen one hundred and thirty-five miles away, and including Mount Wrangel, the highest mountain in North America; of the warm springs near Sitka, of the forbidding character of the coast of the mountain-region, and the grand but gloomy scenery of Prince William Sound. Succeeding chapters are devoted to "Cook's Inlet and its People," "The Great Island of Kodiak," and "The Great Aleutian Chain," which stretches so far to the west as to make San Francisco a half-way city in crossing our country. Chapters are devoted to "The Quest of the Otter," "The Wonderful Seal Islands," and the management and methods of the seal industry. Other peculiar animals to receive due notice are the Alaska sea-lion, the moose, walrus, and polar bear. Far removed in space and character from the Sitka region and the Aleutian Islands are the Innuits, or people of the Esquimo race, who furnish material for a chapter of distinct interest; and the valley of the great Yukon River, and "The Great Northern Wastes," are the sub-

jects of another chapter of equally distinct interest. The graphic descriptions are heightened by pictures of scenery, human life, and occupations, and the constructions of the natives. "How differently," says the author, "a number of us are impressed in the viewing of any one subject, by which observation we utterly fail to agree as to its character and worth!" The remark is pertinently illustrated in this book. The general impression has been that there is not much of value or interest in Alaska. The impression is inevitable, after reading "Our Arctic Province," either that Alaska is one of the most interesting regions of the earth, or that the author is one of those rarely gifted observers who know how to seek out and find matters of interest and beauty where ordinary men would only grope blindly.

A NOMENCLATURE OF COLORS FOR NATURALISTS, AND COMPENDIUM OF USEFUL KNOWLEDGE FOR ORNITHOLOGISTS. By ROBERT RIDGWAY. Boston: Little, Brown & Co. Pp. 129, with Seventeen Plates.

THE preparation of this book has been instigated by the author's feeling of a want while pursuing his own studies as an ornithologist. He could find, on one side, no authoritative nomenclature of colors, and, on the other hand, no compendious dictionary of technical terms used in ornithology, with specific references to the exact parts of the bird to which they were intended to apply. In both cases, approximate identification was the most that could be expected. The identification of color-tints offers peculiar difficulties. The variations are almost infinite, and are subject to modifications by the changing aspects and incidence of the light. Very few natural colors or artificial ones are permanent; most of them are liable to change with time or under chemical influences. The author, in treating of those points, gives a chapter to the discussion of the "Principles of Color," in which he lays down ten color-elements, formed from the primary colors, which in their binary combinations give ninety more or less distinct colors; and these are susceptible of great diversities of intershadings. Seventeen pages are occupied with a "Comparative Vocabulary of Colors," giving equivalent names of colors and shades in six languages. A series of plates gives some two hundred of these colors in actual chromatic illustrations composed out of fine artists' pigments selected from the shops of the best makers as those most likely to be true and permanent in tone. The bibliography gives the names of eight books consulted, in the order of their importance. The second part of the book (the "Ornithologist's Compendium") contains a glossary of technical terms used in descriptive ornithology, and comparative tables of millimetres and English inches and decimals. Six plates in outline are intended to show and localize the parts of the bird and the forms of feathers and eggs.

A TRIP AROUND THE WORLD. By GEORGE MOERLEIN. Cincinnati: M. & R. Burgheim. Pp. 205, with Chromolithographic Plates.

THIS work is attractive on account of its illustrations. The author made the journey which he describes in 1884–'85, for pleasure and recreation, with two companions, who went by his invitation upon a similar errand. The journey included Japan, China, India, and Ceylon, and other Eastern countries, and Europe. The account here given is confined almost entirely to the far East, because it was there the party sojourned the longest, and had the opportunity of viewing the many (to them) strange sights and scenes. A straightforward narrative of what they saw and heard is given, without pretense to learning or literary elaboration, with historical and statistical information obtained from the most reliable sources. The illustrations represent various phases of life and scenery in the East, and are of a very satisfactory character. They were carefully chosen, we are told, from a collection of more than eight hundred original pictures collected during the journey, and are colored true to nature.

COMMERCIAL ORGANIC ANALYSIS. By ALFRED H. ALLEN, F. I. C., F. C. S. Second edition, revised and enlarged. Vol. II. Philadelphia: P. Blakiston, Son & Co. Pp. 583. Price, $5.

THE worth of this originally valuable treatise has been vastly increased by its revision and enlargement. The first edition comprised two volumes, but the work has been so much extended that it was found necessary to issue this edition in three. The

first volume was noticed in the "Monthly" for November, 1885. The second volume, which is now at hand, is devoted to fixed oils and fats, hydrocarbons, phenols, etc. Somewhat more than half of the volume is occupied by the first of these divisions. The physical characters of the oils are described first, and then the reactions based on the chemical properties. These sections are succeeded by a tabular classification of the oils based on a joint consideration of their origin, physical characters, and chemical constitution. Then follow methods of examining fatty oils and waxes for foreign matters and of identifying them, and after that come special methods of assaying some thirty of the principal commercial fixed oils. The next section, on the examination of lubricating oils, and that on mineral lubricating oils, which comes later, contain much matter of interest to the mechanical engineer as well as to the chemist. Appended to this division are descriptions of the chief saponification products of fixed oils—the higher fatty acids, soaps, glycerin, etc. The author has given much personal attention to methods of determining the density of fixed oils, for this property, being largely dependent on the constitution of the oils, is a more or less important means of identification. He especially recommends the Archimedean or plummet method of taking specific gravities, using Westphal's hydrostatic balance. In discriminating between butter and its imitations, he has found the specific gravity test valuable. He also recommends for examining butters the determination of the volatile fatty acids by Reichert's distillation process.

The temperature at which a mixture of the melted fat with glacial acetic acid becomes turbid on cooling is deemed by him another important indication, but he says that further experience is necessary before the trustworthiness of this test can be considered fully established.

The accurate determination of glycerin in a complex mixture is a problem which the author does not consider has received a satisfactory solution under all circumstances. After giving several methods of isolating glycerin in an approximately pure state, available in various circumstances, he proceeds to describe certain processes based on the chemical reactions of glycerin. A method originally suggested by J. A Wanklyn, has been very fully investigated in the author's laboratory, and proved to give very accurate results under certain conditions. This method is based on the oxidation of the glycerin by treatment with permanganate in presence of excess of caustic alkali, whereby it is converted into oxalic acid, carbon dioxide, and water. The excess of permanganate is then destroyed by a sulphite, the filtrate acidulated with acetic acid, and the oxalate determined as a calcium salt. In the presence of foreign bodies yielding oxalic acid on oxidation, the process is evidently useless.

In the second division, after some general description of the hydrocarbons, the tars of various origins are considered, and then the bitumens. The important commercial products derived from petroleum and shale are duly described, after which are taken up the terpenes, benzene and its homologues, naphthalene and anthracene. The properties and methods of assay of monohydric and dihydric phenols are given in the concluding division. The chapters on the aromatic acids and tannins have been deferred to the third volume, which will contain also chapters on coloring-matters, cyanogen compounds, organic bases, albuminoids, etc.

THE SWISS CROSS: A MONTHLY MAGAZINE OF THE AGASSIZ ASSOCIATION. Vol. I, Nos. 1 and 2, January and February, 1887. Edited by HARLAN H. BALLARD. New York: N. D. Hodges, 47 Lafayette Place. Pp. 40 each. Price, 15 cents a number, $1.50 a year.

THE Agassiz Association is an organization for the practical study of Nature, which originated some ten years ago, under an impulse given by the editor of "The Swiss Cross," in the Lenox High-School, Massachusetts. Other societies joined the original society to co-operate with it; and these affiliated local societies or "chapters" have increased till they number nine hundred and eighty-four, having from four to one hundred and twenty members each, of all ages from four years to eighty-four years, distributed in nearly all the States and Territories, and in Canada, England, Ireland, Scotland, Chili, Japan, and Persia. The

chapters are of four different sorts: family chapters, composed of the parents and children of a single family; chapters in schools in which teachers and pupils may join; chapters organized and conducted entirely by young persons; and chapters of adults. The chapters of single States are brought into harmonious action through confederations, which are called Associations, of which the ones most prominent at present are the Philadelphia Assembly and the State Assembly of Iowa. Until this year the Agassiz Association has found in the "St. Nicholas" a medium of communication between its branches and members and with the public; but finding it needed more space than that journal could afford, it was determined to establish a special organ of its own, and "The Swiss Cross" is the result. The opening number is adorned with a full-page portrait of Professor Agassiz. The editor gives a history of the Agassiz Association, from which we derive the facts we have related; and then the real work of the magazine begins. This consists in the publication of papers in natural history, science, experiment, and observation, contributed by members of the Association or other writers; of a "Children's Hour" (in large type); of miscellaneous matter; and of "Reports from Chapters." With these regular features, the second number gives a sketch and portrait of the late Isaac Lea, "the Nestor of American naturalists." The editor has plans for correspondence schools and for association tables at the biological laboratories, some of which are already begun.

HAI-MISHKAN, THE WONDERFUL TENT. By the Rev. D. A. RANDALL, D. D. Cincinnati: Robert Clarke & Co. Pp. 420.

THIS book is described as "an account of the structure, signification, and spiritual lessons of the Mosaic Tabernacle erected in the Wilderness of Sinai." Its design is to give as clear and intelligent a statement as is possible of the literal structure of the tabernacle, and in connection with that to present the spiritual lessons the different parts of the building and its furniture suggest or are designed to teach. The author hopes also that the effect of his work may be to promote the development of the religious faculty of his readers. To make the account more life-like, it is cast in the shape of a narrative of a journey through the wilderness—which the author actually made—and of conversations among the scenes associated with the tabernacle. The account is preceded by a biography of the author, with a portrait.

GEOLOGICAL HISTORY OF LAKE LAHONTAN, A QUATERNARY LAKE OF NORTHWESTERN NEVADA. By ISRAEL COOK RUSSELL. Washington: Government Printing-Office. Pp. 228.

THE explorations reported in this volume are a continuation of the "Quaternary Geology of the Great Basin," begun by Mr. G. K. Gilbert when the present geological survey was organized, and have been carried out by the author and his assistants under Mr. Gilbert's direction. The theory of the work is based upon the conclusion to which the geological evidence points, that the valleys of the Great Basin were at one time—which is determined to have been in the Quaternary period—occupied by an extensive series of lakes, of which those to which the names of Lahontan (after Baron La Hontan, one of the early explorers of the head-waters of the Mississippi) and Bonneville have been given. Lake Lahontan filled a valley along the western border of the Great Basin at the base of the Sierra Nevada; Lake Bonneville occupied a corresponding position on the east side of the Great Basin, at the foot of the Wahsatch Mountains. The former was mostly within the limits of the present State of Nevada, the latter in Utah. Lake Bonneville covered 19,750 square miles, and was 1,000 feet in its greatest depth; Lake Lahontan covered 8,422 square miles, and had an extreme depth, where Pyramid Lake now is, of 886 feet. Lake Bonneville overflowed northward; Lake Lahontan did not overflow. Both lakes had two eras of high water, separated by a period of desiccation. As Lake Lahontan did not overflow, it became the receptacle for all the mineral matter supplied by tributary streams and springs; of which that in suspension was deposited as lacustral sediments, and that in solution as calcareous tufa, or appeared as desiccation products after the lake evaporated. The present lakes of the basin are

of comparatively recent date, and are nearly fresh, for the reason that the salts deposited when the Quaternary lakes evaporated were buried or absorbed by the underlying clays and marls. Mr. Russell's monograph is an attempt to study out the history of Lake Lahontan, so far as the details of it can be deduced from the geological evidences. It considers the "Physiography of the Lahontan Basin," the physical and chemical and life (animals and plants) history of the lake; the climate of the Quaternary period; the geological age of the lake; and the "Post-Lahontan Orographic Movement."

THE CONFLICT OF EAST AND WEST IN EGYPT. By JOHN ELIOT BOWEN, Ph. D. New York: G. P. Putnam's Sons. Pp. 204. Price, $1.25.

THIS essay was prepared originally as a dissertation preparatory to receiving the degree of Doctor of Philosophy from Columbia College. The matter of it is of public interest, and, in the shaping which the author has given it, is presented in a form to make accessible to the public and to inform it concerning a subject respecting which its present knowledge is rather vague. The subject concerns the condition of affairs in Egypt, and how they came to be in that condition, together with the relations of the powers to the questions at issue. Of these matters, Mr. Bowen gives a concise, intelligible account, beginning with the inception of the Suez Canal enterprise in 1854, and following the events and negotiations through the reigns of Said, Ismail, and Tewfik. It presents M. de Lesseps's struggles to get the Suez Canal under way and construct it, and England's efforts to balk the work because it was a French one; the brilliant but reckless career of Ismail, his enterprising views and extravagant speculations, ending in his fall; the attempts, under Tewfik, to remedy the distress which Ismail had brought on; the rebellion of Arabi and the raid of the Mahdi, with Gordon's unfortunate career. England's record, through all these events, has been rather spotted, but Mr. Bowen concludes that "England, in spite of all her mistakes, has had a beneficent influence on Egypt," and that the hope of the country hangs largely on its independence of Turkey being assured.

THE POISON PROBLEM. By FELIX L. OSWALD, M. D. New York: D. Appleton & Co. Pp. 138. Price, 75 cents.

IN this little volume, Dr. Oswald, than whom no writer is braver, more pungent upon occasion, or more readable, discusses the cause and cure of intemperance. In the beginning he calls attention to the extent and enormity to which the consumption of liquors has grown, and the power the liquor-traffic has acquired, which are really facts to be alarmed about. The argument is based upon the assumption, which is maintained by many considerations, that alcohol is a poison without any beneficial qualities to the system, the appetite for which, when once acquired, grows, and can not be mitigated by any measures of mere temperance, or by compromises. No moral or social evil is greater than those to which it conduces. "Judging from secular standpoints," says Dr. Oswald, "we should be inclined to think that alcohol is doing more mischief in a single year than obscene literature has done in a century. . . . And, unhappily, it also involves the loss of self-respect, and thus destroys the basis on which the advocate of appeals to the moral instinct would found his plan of salvation. The power of moral resistance is weakened with every repetition of the poison-dose, and we might as well besiege a bedridden consumptive with appeals to resume his place at the head of an afflicted family." The banishment of alcohol from the sick-room, as well as from the banquet-hall, is demanded. "Thousands of topers owe their ruin to a prescription of 'tonic bitters.'. . . Taught by the logic of such experiences, the friends of reform will at last recognize the truth that the 'temperate' use of alcohol is but the first stage of a progressive and shame-proof disease, and that, moderation and repudiation failing, we must direct our blows at the root of the upas-tree, and adopt the motto of 'eradication.' Truce means defeat in the struggle against an evil that will reproduce its seed from the basis of any compromise." For remedies against the spread of the alcohol-habit, the author proposes instruction respecting the physiological effects of the drug, such as is provided for in the school systems of several States; proscription of its use under all circumstances; the

provision and encouragement of healthier amusements, from which alcohol shall be conspicuously absent, as it is now conspicuously present in or near most ordinary amusements; and prohibitory legislation. Our temperance friends will hardly find a stronger document in support of their cause than Dr. Oswald offers them.

THE OLD ORDER CHANGES. By W. H. MALLOCK. New York: G. P. Putnam's Sons. Pp. 313. Price, $1.

MR. MALLOCK, the author of "Is Life worth Living?" is well known as a forcible writer on morals and social questions. The present book is a love-story, in which are interwoven discussions of the "labor problem" and "scientific morals." The bearing of the whole may, perhaps, be learned from the motto, which is a sentence of Bastian's, translatable into—"This importunate political economy insinuates itself everywhere, and mixes itself in everything, so that I really believe that it is it that says, 'I think nothing human foreign to me.'"

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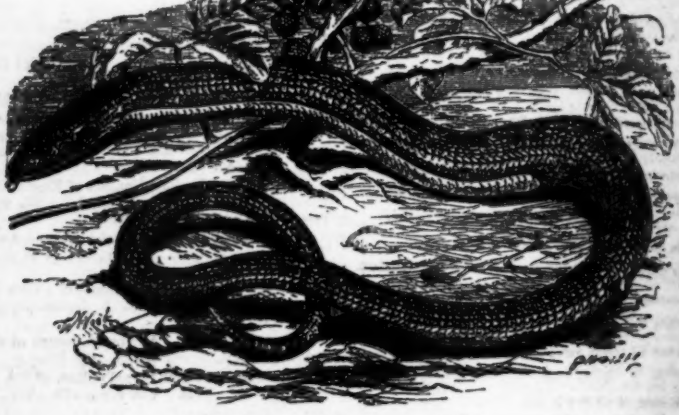
## POPULAR MISCELLANY.

**The Glass-Snake.**—We publish in this number of the "Monthly" two letters respecting the so-called joint-snake, of which the one by Dr. Hammond gives a clear and correct account of the natural history of the reptile, and ought to dissipate all doubts as to the origin and value of the stories that have been told respecting its peculiarities. It appears that the rejoining of the dissevered pieces of the animal is the only part of the stories that does not rest upon a rational foundation. The *Ophisaurus* of Dr. Hammond is also figured and described in Wood's "Natural History," from which the accompanying illustration is borrowed (Vol. III, p. 51), under the name of "the glass-snake." After speaking of the reptile as a native of North America, Dr. Wood says: "In this creature there is not even a vestige of limbs, so that it is even more snake-like than the preceding species [Scheltopusic, *Pseudopus Pallasii* of Africa]. The generic title of Ophisaurus is of Greek origin, signifying snake-lizard, and is given to the reptile on account of its serpentine aspect. The reader will remember that on page 48 there is an account of the saurophis [*Saurophis tetradactylus* of South Africa, which has four insignificant, very weak limbs], a name which is exactly the same as that of the present species, except that the one is called the lizard-snake and the other the snake-lizard, a distinction which, in the present case is without a difference, so that the two reptiles might exchange titles and yet be appropriately named. The glass-snake is indeed so singularly like a serpent that it can only be distinguished from those reptiles by certain anatomical marks, such as the presence of eyelids, which are wanting in true serpents, the tongue not sheathed at the base, and the solid jaw-bones, which in the serpents are so loosely put together that the parts become widely separated when the mouth of the creature is dilated in the act of swallowing its prey. The glass-snake



GLASS-SNAKE (*Ophisaurus ventralis*).

is one of the earliest of the reptile tribe to make its appearance in the spring. . . . It is generally found in spots where vegetation is abundant. . . . It is fond of frequenting the plantations of sweet-potato, and during harvest-time is often dug up together with that vegetable. The home of this reptile is made in some dry locality, and it generally chooses some spot where it can be sheltered

by the roots of an old tree, or a crevice in a convenient bank. It moves with tolerable rapidity, and its pursuer must exercise considerable quickness before he can secure it.

"To catch a perfect specimen of the glass-snake is a very difficult business, for when alarmed it has a remarkable habit of contracting the muscles of its tail with such exceeding force that the member snaps off from the body at a slight touch, and sometimes will break into two or more pieces if struck slightly with a switch, thus earning for itself the appropriate title of glass-snake. Our common blind-worm . . . possesses a similar capacity, and often uses it in rather a perplexing fashion. Catesby remarks that this separation of the tail into fragments is caused by the construction of the joints, the muscles being articulated in a singular manner quite through the vertebræ. The tail is more than twice the length of the body, from which it can only be distinguished by a rather close inspection. The head of the glass-snake is small in proportion to the body, rather pyramidal in shape. Along each side of the body runs a rather deep double groove. The coloring of this creature is extremely variable."

**Antiquity of Speaking Man.**—In considering the question of the antiquity of speaking man, Mr. Horatio Hale avails himself of the theory which was suggested to Professor de Mortillet by the structure of a jaw-bone found in the cave of La Naulette in Belgium, that palæolithic man, who in this case could with more propriety be styled the precursor of man, was speechless. The jaw-bone in question is destitute of what is called the "mental tubercle," or the "genial tubercle," an appendage peculiar to man, which is indispensable to that freedom of the movements of the tongue that is essential to the possession of articulate language. Such a speechless man as this one may have been would be, as Professor Whitney remarks, "a being of undeveloped capacities, having within him the seeds of everything great and good, but seeds which only language can fertilize and bring to fruit; he is potentially the lord of Nature, the image of his Creator, but in present reality he is only a more cunning brute among brutes." Having reached a certain level, it is impossible for him to go above it. Hence, the dead uniformity in the character of the relics of man of this race. The next race, the race of Crô-Magnon, offered in some respects the strongest possible contrast to this one. It possessed the genial tubercle, with good cranial development and intellectual powers, the refinement of which is attested by the pictures it has left engraved on pieces of stone, ivory, and bone, and sculptures on bone and ivory, the spirit of which would be creditable to any artist. It is impossible to suppose that people possessing such faculties and speech would remain long in an uncivilized state if they were once placed in a country where the climate and other surroundings were favorable to the increase of population and to improvement in the arts of life. Various calculations of the age at which this race flourished place it at from four to eight thousand years ago, which is fairly consistent with the accepted chronology of the prehistoric life of the oldest historical nations, and we thus have the early origin and sudden outburst of civilization in ancient Egypt and Chaldea accounted for. If a pair of human beings, possessing the gifts supposed, appeared in some region where the climate and natural productions were favorable, what time would be required for their descendants to become numerous enough to found the early communities of Egypt and Mesopotamia, and to spread into Europe and Eastern Asia? "The question is easily answered. Suppose the population to double only once in fifty years, which is a very low estimate, it would amount in twelve hundred years to about forty million, and in fourteen hundred years would be over six hundred million, or nearly half the present population of the globe. That less than a thousand years will suffice to create a high civilization, the examples on our own continent, presented by the Mexicans, the Mayas, the Muyscas, and the Peruvians, amply prove. And that the same space of time would be sufficient for the development of the physical peculiarities which characterize the various races of men, by climatic and other influences, is made clear by the evidence accumulated by Prichard, De Quatrefages, Huxley, and other careful and trustworthy investigators."

**The Canadian Climate.**—In a paper on "The Influence of the Canadian Climate on Europeans," which he read at the British Association, Professor W. H. Hingston said that the heat of the summer in Canada was more easily endured than the humid summer weather often experienced in Europe. The skin was called into greater activity, and the heat of the summer weather acted very strongly on the liver; but if European residents adopted the indigenous customs of the country, lived moderately and temperately, and led an active existence, their livers would give them no trouble. The cold weather in winter stimulated people to activity. The mortality in early life was large, because in no country in the world were there so many children, but the mortality in adult life was not large. With the exception of Malta, the Canadian stations used to be considered the healthiest posts of the British army; and there were really no diseases peculiar to the country, while many which prevailed in England and on the Continent of Europe had no existence there.

**The Carpet-Beetle.**—The carpet-beetle, which is commonly, but with no good reason, called the buffalo-moth, is a dermestoid beetle whose scientific name is *Anthrenus scrophulariæ*. It is a foreigner, and was introduced into this country from Europe in 1872. It has since made itself at home in every part of the United States. It is about one twelfth of an inch long, and is prettily marked with regular patches of white and red upon a prevailing black ground. It feeds upon the pollen of flowers, of which it gives the preference to spiræa. It is destructive to carpets, and to nearly all animal substances, in the larval state. Carpet-linings give protection against the pest to all of the carpet they underlie, but the part of the carpet near the base-board is unprotected, and is liable to be infested and eaten by them. It is there that defensive measures should be applied. The beetles are nearly proof against ordinary moth-exterminators, and call for stronger remedies. Benzene is one of the best of them; it is efficient, simple, not dangerous, and easily applied. It can be poured on from a tin can having a slender spout, with a nozzle that will let out a stream as large as a knitting-needle. Naphtha, kerosene-oil, and gasolene are remedies of similar character and likewise easily used. Kerosene and naphtha are a little objectionable on account of their odor; kerosene also on account of its greasiness, and gasolene on account of its inflammability. Ironing wet cloths applied over the edges of the carpet is recommended; the beetles are killed by the steam that is generated. Painting with corrosive sublimate bed-bug poison is a sovereign remedy for all vermin. The beetle does its worst work in June, July, and August. The larvæ live in the cracks of the floor during the winter; and it is feared that, under the present methods of heating, the habit of producing a second brood in the colder months is likely to be induced.

**The Ruins of Quirigua, Central America.**—The ruins of Quirigua, in Central America, according to the account of Mr. A. P. Maudsley, are completely hidden in a thick tropical forest, on the left bank of the river Montagua. They consist of numerous square or oblong mounds and terraces, varying from six to forty feet in height, some standing by themselves, and others clustered in irregular groups. Most of these mounds were faced with marked stone, and were ascended by flights of stone steps. "The interest centers in the thirteen large carved monoliths which are arranged irregularly round what were probably the most important plazas of the pueblo. Six of these monuments are tall stones measuring from three to five feet square, and standing from fourteen to twenty feet out of the ground; five others are oblong or rounded blocks of stone shaped so as to represent huge turtles or armadillos, or some such animals. All these monuments are covered with elaborate carving; usually on both back and front of the tall monoliths is carved a huge human figure standing full-face, and in a stiff and conventional attitude. The sides of the monuments are covered with tables of hieroglyphics, most of them in fairly good preservation. In addition to these tables of hieroglyphics, there are series of squares or cartouches of what appears to be actual picture-writing, each division measuring about eighteen

inches square, and containing usually two or three grotesque figures of men and animals. The design of these picture-writings shows considerable variety and freedom of treatment as compared with the large-sized human figures, in the execution of which the artist seems to have been bound by conventional rules. The largest of the stone animals is perhaps the most remarkable of all the monuments; its measurement is roughly a cube of eight feet, it must weigh nearly twenty tons, and it rests on three large slabs of stone. It is shaped like a turtle, and is covered with the most elaborate and curious ornament, and with tables of hieroglyphics and cartouches of picture-writing. The greater part of the ornament throughout these carvings is formed from the grotesque representations of the human face or the faces of animals, the features frequently so greatly exaggerated that it is most difficult to recognize them; but a careful examination enables one almost invariably to trace back to this facial origin what, at first sight, appears to be merely conventional scroll-work. Forms derived from leaves or flowers are altogether absent; occasional use is made of a plaited ribbon, and a very free use of plumes of feathers, which are often most gracefully arranged and beautifully carved. The fifteen monuments are divided into two groups; in one the human figures are all of men; in the other, of women. It might be rash to argue from this that women had attained a high place in the social arrangement of the people who raised these monuments; but there is one other feature that certainly may be admitted as showing an advanced and peaceful condition of existence, and that is the entire absence of any representation of weapons of war." Casts of the largest of the monoliths, of the turtle, and of all the tablets of hieroglyphics, are on exhibition in the Archæological Museum at Cambridge, England.

**Petroleum in Egypt.** — Oil has been "struck" in Egypt by boring in the Jebel Zeit (Oil Mountain), on the shore of the Red Sea, one hundred and eighty miles from Suez. Petroleum has long been supposed to exist in the country, for the ancient mummy-cloths were soaked in it, and the exudations from the fissures of this very mountain have been used by the natives, from time immemorial, as a specific for rheumatism and skin-diseases. Oil was definitely mentioned as a production of the Red Sea country, and an analysis of a sample of it was given in a book published by Mr. Norman Tate, in 1864, but nothing more precise is known concerning the statements he makes. Some two years ago, M. Debay, a Belgian engineer, proposed to exploit for petroleum, and finally obtained a concession to do so, which was to expire on the first day of March, 1886. He started his borings after a long delay, and at last, on the last day of the life of his privilege, got at the depth of thirty-five metres signs of oil sufficient to satisfy the conditions of his contract. With continued borings an outflow of five hundred tons of mixed water and petroleum has been obtained, of which the pure petroleum constituent was estimated at at least one hundred and fifty tons. The Egyptian Government is looking out for companies to work its oil. It intends to avoid a monopoly, and will divide the land into portions, which will be ceded for a sum in cash and a royalty on all production.

**The Theory of Earthquakes.**—Professor J. S. Newberry defines an earthquake, so far as present knowledge permits it to be defined, as a movement caused by a shrinking, from the loss of heat, of the heated interior of the earth, and the crushing together and displacement of the rigid exterior as it accommodates itself to the contracting nucleus. As the nucleus contracts, the solid crust can not accommodate itself, moment by moment, to the loss of volume, for it resists by its rigidity and is brought into a state of strain. This is relieved from time to time, whenever it passes the resistance of the materials composing the crust, by a crushing together and displacement of the surface rocks. These are faulted or folded; that is, are either thrown into great waves by lateral pressure, or the arches are broken and fissures are produced at right angles to the line of thrust. The rocks forming the sides of these fissures slide on each other, forming what geologists

call faults, in which the "throw" or displacement sometimes amounts to many thousand feet. Earthquakes, mountain-chains, and volcanic eruptions may all be considered as consequences of this readjustment. It is evident that the folds and fractures seen in every mountain-belt could not have taken place without great disturbance of the surrounding country; and as they have been formed, not all at once, but each by itself, and each one by many paroxysms, an almost infinite series of earthquakes is recorded in the structure of every mountain-chain. The lines of fracture which are marked by mountain-chains are ever, after the first disruption, lines of weakness, where the resistance to lateral pressure is diminished, and where the strain of large unbroken areas is relieved from time to time by displacements, necessarily attended by earthquakes. So along up the Atlantic slope of the Alleghanies there have been many earthquakes since the country was occupied by the whites. Not a year passes that we do not hear of several in New England, the Middle, or Southern States. As the population increases, the number of observers is multiplied and the number of structures liable to damage constantly added to; so that such phenomena now attract more attention and cause greater destruction than formerly. When the data already collected in regard to the Charleston earthquake shall have been tabulated, it will doubtless be found that the displacements which occasioned the vibrations were located along a line parallel with the Alleghanies and at a depth of from ten to twenty thousand feet, not under but westward of the city.

**The Ornithorhyncus.**—Dr. Pfuhl, in his lecture on "Animal-Plants and Plant-Animals," published in our last number, spoke of the ornithorhyncus as being a true mammal, and bringing forth its young alive. Such was believed to be the case till very recently. Mr. W. H. Caldwell, who has resided for some two or three years in Australia engaged in special investigations of the mysteries connected with the mammals of that country, has recorded the discovery that the monotremata, or animals of the order of which the ornithorhyncus is a member, are oviparous, and lay eggs, the development of which bears a close resemblance to the development of the eggs of the reptilia. He has read several papers relative to his investigations before the scientific societies of New South Wales, in one of which, before the Linnæan Society, he exhibited specimens that he had obtained in Queensland, showing the stages in the development of the animals from the laying of the eggs to the hatching.

**Some Inherited Phenomena of Alcoholism.**—Dr. T. D. Crothers, of Walnut Lodge, Hartford, Connecticut, has made a study of a class of phenomena which have not been previously described specifically, in which a liability to exhibit the outward signs of intoxication upon excitement appears to have been inherited from inebriate parents. He has found two classes of the cases: one, in which the symptoms of intoxication are present all the time; the others in which those symptoms only appear from some peculiar circumstances or exciting causes. In the first class, some prominent defect, such as idiocy, imbecility, or congenital deformity, is present to give the case a distinctness irrespective of the signs of intoxication. The symptoms may appear after birth, or be slowly evolved with the growth of the child, and come into prominence at or before puberty. Of course, all the varied phases of idiocy, imbecility, progressive degeneration, and malformation go on. The presence of a special class of symptoms resembling intoxication so clearly, suggests a distinct alcoholic causation. In the second class of cases noted, the alcoholic symptoms are not present, unless from some exciting cause (non-alcoholic), such as anger, fear, or sudden excitement. In this class are idiots, imbeciles, and defectives of all degrees, who at times display distinct signs of intoxication, that subside after a period. Often in these cases appear the common delusions and deliriums of intoxication; also, the semi-paralysis and stupor. Teachers and superintendents of asylums and schools for this class realize clearly the danger of excitement on these dements and defectives, throwing them into various states of mania, as well as intoxication. Several remarkable incidents illustrative of these

principles are cited, the grouping of which makes it evident to the author that symptoms of alcoholic poisoning can not be trusted as evidence of the immediate use of alcohol; and that the excessive use of alcohol leaves a permanent defect or impress on the brain, which will go down into the future with great certainty. It may be concealed for a lifetime in the child of a drinking parent, but may come to the surface at any moment, from the application of its special exciting cause; or it may appear in some other form of defect, which can be traced back to the injury from the toxic action of alcohol.

**Potable Water.** — The unsatisfactory character of all purely chemical examinations to determine the wholesome potability of water has long been tacitly admitted. It has more recently been demonstrated that such examinations do not go to the root of the matter, for the quality of water is dependent on the presence or absence of certain bacterial growths. Frankland's combustion process, Wanklyn's ammonia process, and Schützenberger's permanganate of potash method, were all attempts to estimate the organic matter, and, to some extent, its qualities; but they, and all chemical processes, deal with dead matter only, or, rather, fail to draw any distinction between the living and the dead; and, judged by these standards, the water in which vegetables have been boiled, or a cup of meat-broth, or of coffee, would rank far worse than water containing a small quantity of enteric or choleraic stools, or even than the anthrax-bearing waste from a mohair-factory. Bacterioscopic examination of water, the object of which is to determine the bacterial life, or the disease-germs and their activity, has been employed for some years in Germany, and is making headway in England. By this method we are enabled to ascertain the number of living bacteria in a cubic centimetre of water. Koch's results showed the relation between this number and the purity of waters, as well as the effect of filtration, when he was able to announce that the numbers were, for Berlin sewage, 28,000,000; for the waters of the Spree, 118,000; for the effluent from sewage-farms, 18,000; from the Rummelsberger See, 32,000; from the Stralau water-works, before filtration, 125,000, and after filtration, 120. In the best well-waters it is from 30 to 60, and in boiled distilled water from 4 to 6. From this it appears that any number under 100 indicates an irreproachable water, and under 200 a potable one; while polluted rivers count their thousands and sewage its millions. Still, this method fails to distinguish between innocent and pathogenic organisms. Some of them can be identified by their mode of growth in tubes of nutrient gelatin, by their behavior with coloring reagents, and by other methods, even when in themselves morphologically alike and indistinguishable under the microscope. Dr. Dupré suggests an easier and speedier plan, dependent on the fact that some microbes can and others can not survive exposure to certain degrees of heat, and that while dead matter rapidly absorbs oxygen from permanganate of potash, it does so to a very slight extent, if at all, from the water itself, at least within a limited space of time. He is directing his attention to the points that the amount of oxygen taken from the water in its natural condition may be contrasted with that taken from the permanganate; that it may be contrasted with that taken up after any living organisms in the water have been killed by the application of heat; that a degree of heat may be applied sufficient to kill developed organisms or certain germs and spores, but insufficient to kill other kinds of germs and spores, and if this degree of heat be known for the several kinds of germs and spores, a judgment may be formed as to the nature of the germs and spores present; and that some substances, sterile in themselves, but capable of nourishing any living organisms contained in the water, may be added, and the increase in the amount of oxygen absorbed may be noted. Among the practical results to which Dr. Dupré has come, are: A water which does not diminish in its degree of aëration, or, in other words, which does not consume any oxygen from the dissolved air, may or may not contain organic matter, but presumably does not contain growing organisms. Such organic matter, therefore, as on analysis it may be found to contain, need not be considered as "dangerous organic impurity"; a water which,

by itself, or after the addition of gelatin or other appropriate cultivating matter, consumes oxygen from the dissolved air at lower temperatures, but does not consume any after heating to 60° C. for three hours, may be regarded as having contained living organisms, but not of a kind able to survive exposures to that temperature; and a water which, by itself or after the addition of gelatin or the like, continues to consume oxygen from its contained air after the water has been heated to 60° C., is to be regarded as containing spores or germs of organisms that can survive that temperature. Whether the power of resisting a given temperature affords any clew to the innocence or malignity of an organism is a question for future biologists, and must be decided by separate observations on each known species.

**Amianthus.** — Amianthus is a mineral consisting of a double silicate of hydrate of lime and magnesia with a little oxide of iron or alumina. It generally occurs in the form of silky fibers, sometimes nacreous and having a greasy feeling, qualities that give it a kind of organic aspect. It is incombustible and infusible. It appears to burn in the fire, but when it is withdrawn from the flames it immediately returns to its natural condition without having undergone any alteration. This property seems to have been known from very early times. The ancients are said to have used it for winding-sheets for the bodies they placed upon the funeral-pyres, the cloths made of it holding the ashes of the dead separate from those of the fuel. Whether this be so or not, the secret was lost, and amianthus was, till quite recently, nothing but a natural curiosity. The art is now practiced of introducing amianthus into woven goods and of making with it a considerable number of incombustible objects, such as gloves, garments, and safety-ropes. It has also been introduced into paints and protective coverings for wood. As it is a poor conductor of heat, is not attacked by acids, and does not act on metals, it makes a good envelope, and has been found excellently adapted to application at the joints of steam-pipes. The manufacture of amianthus is carried on by an English company formed by the amalgamation of three rival Anglo-Italian companies, which has control of the most important beds of asbestus known, particularly of those in England, Italy, Corsica, and Canada. The Italian asbestus is most sought after, on account of the length, fineness, softness, and flexibility of its fibers. The fibers of the mineral of other countries are shorter, harsher, and less easily separated, and, therefore, inferior. The fibers, the mineral having been passed through a rolling-mill, are stirred in a bath of hot water till they become very supple. The longer fibers are then taken out, washed, and sorted into packages of uniform length, to be spun into threads and woven into cloths, for garments of various kinds, or into cords. The shorter fibers are beaten into a powder, and then mixed with linseed-oil into a pulp very like paper-pulp, to which India-rubber is added to give elasticity; and this makes an excellent paint for protection against heat, particularly suitable for application to steam-conductors, boilers, joints, furnishing of every kind, and wood.

**A River made a Nuisance.**—The "Lancet" records the failure of the system which has been applied, with great expense, for disposing of the sewage of London by turning it into the lower part of the Thames. It declares it the greatest nuisance of England, and charges it with having made the Thames a cesspool throughout its tidal region. "Of the existence of a tremendous nuisance," it says, "and of the urgent danger to which it exposes the metropolis, there is no longer any room for doubt. Hard as the Metropolitan Board of Works fought, they were utterly crushed by the evidence brought before the late Royal Commission, and by the stinging words of the commissioners in their reports. They have, indeed, practically admitted the whole case against them by adopting a costly system of disinfection which could only be justified by urgent necessity. The disinfection, it is true, is a sham, utterly useless, and a gigantic waste of the money of the rate-payers; but it is none the less a confession of the existence of a nuisance created by the board, and for many years defended by them as a public blessing."

**The Blue Grotto of Busi.**—The "Blue Grotto" of the Island of Busi, in the Dalmatian Archipelago, which is illuminated by submarine light, was discovered in 1884, and has become one of the most noteworthy sights of that interesting quarter of the Adriatic. The Island of Busi, which is inhabited and well cultivated, takes its name from the Venetian *busi* (Italian *buchi*) caves, on account of the dozen, more or less, of grottoes that exist upon it. It lies southwest of the Island of Lissa, and being only about five miles from the port of Cornise on that island, can be reached from it after about seventy or eighty minutes of rowing. It is rich in subterranean and submarine caverns, which have been only partly explored. Count von Ransounet is acquainted with ten of these, all accessible only by boat. The largest of them, which is called Medvedina, or the Bear's Cave, is about five hundred feet long, and presents a spacious interior with imposing rock-effects. The most remarkable of the caves so far explored, is the Blue Grotto, which is called by the inhabitants the ballon-cave, from the name of the rock promontory Ballon, on the northeastern coast of the island under which it lies. The entrance to the cave is in the farthest recess of a bay on the northeast side of the island, and is about seven feet wide and five feet high, with sixteen feet depth of water, and spacious enough to admit, when the sea is still, a boat carrying ten or twelve persons. This entrance forms a thread-like canal, inclosed between steep walls, which is shrouded in its first half in deep darkness; but the farther one presses in, the more evident and clear becomes a peculiar twilight effect, by which one can soon discern the breadth and height of the interior, illuminated by a surprising play of colors. At first the water under the keel of the boat appears of a dark blue-green; then the color gradually changes to a clear blue, and at last to an azure, which grows lighter and brighter. Soon the visitor finds himself set, as if by enchantment, into a broad, high space, the ground of which is filled with a brilliant, shimmering, blue flood, whence streams out a soft light, covering everything visible with a strange glamour. The illumination appears to come from under the sea. The oars appear silver-white in the transparent blue flood, and the stones under the water like semi-lustrous silver, while the waves themselves exhibit the various changes of the shades of blue. The hollow of the grotto is thirty-one metres long, from fifteen to seventeen metres wide, and between sixteen and eighteen metres deep. The water, which appears to extend still farther under the rocks, receives its light through a submarine door of ten and a half by eighteen metres; and the silvery shimmer with which the submerged rocks are lighted is an effect of the sunlight reflected from the water. This effect is particularly charming on a rock-bridge under the water, extending clear across the cave. Beyond this bridge may be seen, through a cleft in the rock, a second blue cave of smaller dimensions and different light-effects.

**British Health Resorts.**—The health resorts of Great Britain have the advantages—to Englishmen—of being convenient of access and of being conducted according to British ideas of comfort. Their disadvantages are those of a cool and humid climate, and the long, dreary, sunless winter. The sea-side resorts are probably the most important. Of them, those of the east coasts—Ramsgate, Cromer, Redcar, and Whitby—are stimulating; those of the west, especially of the southwest—Bournemouth, Torquay, Penzance, and Ilfracombe—sedative; and those upon the southeastern littoral—Eastbourne, Folkestone, and Hastings—hold an intermediate position. The selection must depend upon the physician's appreciation of the finer points in his patient's case, but it is far from being a matter of indifference, and the indiscriminate recommendation of sea-air, without regard to the different watering-places, is an inexcusable error. If the invalid is intolerant of marine influence, he may make a selection from a variety of inland resorts. Tunbridge Wells is mild and sheltered, Malvern is more tonic, and Buxton, Ilkley, Harrogate, Weymouth, and Crieff are bracing and stimulant. The gouty and rheumatic may find benefit at the mineral springs of Bath, Cheltenham, Droitwich, Matlock, Leamington, Woodhall, and Harrogate in England, Moffat and

Strathpeffer in Scotland, and Ballynahinch and Lisdoonvarna in Ireland. But these places are now not so much in fashion or so attractive as the Continental resorts, and afford, as Dr. Yeo has pointed out, an inferior variety of advantages. The great variableness of English seasons is, however, very embarrassing in the case of consumptive patients, although there are places among the milder resorts where benefit is derived in favorable seasons. Great Britain is, however, wholly without places where the rarefied air of great altitudes can be applied to cures, as at Davos Platz, and will probably never have them, for the British winter presents meteorological conditions diametrically opposed to the brilliant sunshine and intense dryness to which the climate of the upper Alps owes a large part of its efficacy.

**The Inconveniences of Law-Codes.**—Mr. E. T. Merrick, in a letter to David Dudley Field and others, committee on the delay and uncertainty of judicial administration, objects to the formation of codes, as tending to give laws too rigid a character. According to his reading and observation, "the transition from the elastic system of principles, resting on pure reason, to a system of positive law, is marked at first by a liberal interpretation corresponding more to the equity of the older system. But, little by little, from veneration or some other motive or cause, the words of the statute law are considered of more sanctity and come to be more rigorously executed, until at last it is thought that it is of more importance that the law should be strictly observed than that equity should be done. How often have the judges felt constrained to enforce statutory laws, against which their sense of justice revolted!" It would be much better, in Mr. Merrick's view, to leave it to wise judges "to select from the great storehouse of principles, which admit of an infinitude of exceptions, such as are fitting the new subjects brought for their determination, than to leave it to less experienced men who happen to have the power as legislators to freeze principles into rigidity." Codes may be a matter of necessity under some circumstances, but room should be left in every system of laws for adaptation of judicial construction to special conditions and contingencies, "for it seems presumptuous in any body of men to attempt to regulate, by absolute terms, future affairs and rights respecting things the existence and relations of which they can not possibly foresee." Provision for giving flexibility to the English common law is afforded by chancery; and in the United States, the opinions of the courts of every State are exerting more or less of influence on the courts of every other State, on all questions arising under the common law, whereby the judges of all the States are building up one homogeneous system.

**Meerschaum.**—Meerschaum ranks among the most important mineral products of the Turkish Empire. It is a magnesite or hydro-silicate of magnesia, and is found in extensive masses in the lower transition beds, in the Crimea and the Island of Negropont, but most abundantly in Asia Minor. The center of the principal district where it is mined is at Eski-Sheir, the ancient Dorylaion, a town of nine thousand inhabitants, situated in a valley watered by the Thymbres River, in a district famous for its thermal waters. Most of the meerschaum mined here is exported by way of Brusa to Vienna, while the waste is bought by the North-German manufacturers of pipe-bowls and mouth-pieces, whose chief center is at Rubla, in the Grand-duchy of Saxe-Weimar. Some twenty beds of the magnesite are worked near Eski-Sheir. They belong to the Turkish Government, but are farmed out to European companies, some of which have been on the ground for more than twenty years. The companies employ some four thousand workmen, who come chiefly from Germany and Italy. Magnesite earths are also found at Vallecas, near Madrid, in Spain, under saliferous clays, at Salinelle, in the department of the Garo, and at Saint-Ouen and Conlommiers, France, where they occur in fresh-water beds under the gypsum.

**A Fruit-Evaporator for the Public.**—The Fruit and Vegetable Growers' Association of the United States, at its meeting in Columbus, Ohio, gave especial consideration to the question of the best methods of pro

paring fruit for the market and preserving it for family use. The method by evaporation was especially commended. Mr. Ezra Arnold, of Illinois, presented drawings and specifications of a cheap evaporator made and used by himself, with which he had had better success than with the more expensive dry-houses and evaporators. It is very simple in construction, and with it the inventor could dry apples in two hours; strawberries in three hours; peaches, cherries, and corn in two hours, etc. He did not intend to make or sell evaporators, but would consign to the Association his right and title in the invention, provided that body would procure cuts to illustrate the different parts, and would distribute gratuitously complete illustrated directions for making and using the evaporator. His proposition was accepted by the Association. (W. Orlando Smith, secretary, Alliance, Ohio.)

**The Mexican Luminous Beetle.**—Carl Heinemann, of Vera Cruz, has published observations of the Mexican *cucuyo* (*Pyrophorus*), or luminous beetle. Each beetle has three lamps—a pair of small lamps on the prothorax, near the margin, and a large lamp in its abdomen, all developments of the hypodermis, and largest in the male. Though the light is usually nocturnal, yet, if the animal is disturbed by day, it will shine, but less brilliantly, and a sleeping *cucuyo* will show in a dark chamber a mild light; and if at such time it is awakened, and breathing begins, the light will appear in its splendor. There are two degrees of luminosity—one soft and the other bright—which may be termed, respectively, the cell-light and the tracheal light, and one may change into the other by stimulation. In a dark room the light appears clear green, inclining to blue; in daylight it is yellowish. The spectrum analysis has not been satisfactorily effected, but the light seems to produce a spectrum wanting in half the blue and deficient in the red. An extracted luminous organ will continue to give red light for some hours. No light-nerves were found, and so far there was no evidence of the luminosity being under control of the will. The abdominal light, at least, depends only on the respiratory center. The expiration only of the abdomen is active, and the inspiration is the passive act of the abdominal muscles returning to their place of rest. On every such inspiration the air brought by the trachem causes the luminous organ to give its bright, steady light. It is manifest that the light depends on a process of chemical oxidation. Mechanical irritation, chemicals, and electrical stimulus never succeeded in exciting more than the mild cell-light. But a stream of atmospheric air, or of oxygen, brought out the brilliant tracheal light. For the continuance of the light, both oxygen and moisture are favorable. The luminous process goes along with the production of a greenish-yellow substance which is found diffused in the luminous cells; and this yellow can be fixed. The author believes that a substance is produced in the luminous organ which, on contact with oxygen, burns and gives out light. The ashes produced are rich in phosphoric acid, and from this he concludes that there is a burning of some phosphorous body.

**Isochromatic Photography.**—Mr. Frederic E. Ives, by washing his plates with a chlorophyl solution in addition to the ordinary preparation, takes photographic pictures in which all the colors and tones of color—including those which the ordinary plates do not return—are represented in their proper gradations of light and shade. A chlorophyl solution made from blue-myrtle leaves has been found to be the best, although that from a few other leaves may be equal to it. The quality of the plates, when they are to be used immediately, is improved if the solution contains a trace of eosine. But the chlorophyl solution without the eosine may, by adding a little zinc in the preparation, be kept for a considerable time without losing its efficacy.

## NOTES.

THE "Lancet" sees in precocity simply the early or premature use of the higher cerebral centers, particularly those which stand in near relation to the senses. Even when the higher intellectual centers are affected, the excitation may usually be traced through channels which originate in the senses. The calculating boy is gifted with a specially acute perception of sight- or sound-phantoms, which are so clearly

apparent to his consciousness that he works out sums mentally with the ease of an expert using slate and pencil. In like manner a person of keen sound-phantoms may compose music or make verses.

CAOUTCHOUC has been extracted from the *Sonchus oleraceus*, a common weed of the road-sides and barren places in France.

MADAME ZALUSKA, in the "Revue Scientifique," is authority for the statement that the lowest temperature that M. Wroblewski has produced, by allowing liquefied hydrogen to escape, is — 211° C., or about — 380° Fahr. At this temperature, she adds, neither gases nor liquids exist, but everything is solidified. The metals lose their electric resistance, and the current passes through matter without developing heat in it.

THE tides of the Mediterranean Sea, though much reduced, are as real as those of the ocean. Along the littoral of the maritime Alps they average from fifteen to twenty centimetres, with ten and twenty-five centimetres as the extremes. At Gibraltar, they rise to from 1·60 to 2 metres; at Trieste, to 0·70 metre; at Venice, from 0·50 to 0·60 metre; and in the Gulf of Gabes from a metre and a half to two metres.

MR. J. THEODORE BENT says that "binding is the spirit of the modern Greek charm. They bind diseases to trees; they bind fleas, bugs, and lice outside their houses, or rather they make ineffectual attempts to do so; and the shepherds of Donkey's Island (Gatharonisi) are careful to bind beneath the knee of a ram or he-goat the bone of a fish or hare, which they believe is effectual in preventing the offspring from being carried off by robbers."

THE "Saturday Review," in noticing Professor Milne's book on "Earthquakes," accredits the author with having "probably done more than any man living to improve methods and apparatus for observation, and to find a scientific explanation of these crust-movements."

A COMPANY has been formed to apply the water-power of the falls of the Rhine at Schaffhausen to the electrical production of aluminium by the Cowles process.

THE "Saturday Review" finds, in the character of the articles published in the "Sanitarian," evidence that Americans are not a whit behind the English in their appreciation of the inestimable value to a nation of due attention to the measures necessary for the preservation of health; but it also learns from one of the articles that both our national and State Legislatures "give but scant encouragement to those bodies which take care of the public health."

PROFESSOR COLLETT, of Norway, says that the beaver is now extinct in Northern Norway, but that about a hundred individuals are still living in some of the southern provinces.

A CORRESPONDENT of the London "Spectator" objects to the wires now used instead of the old thread for stitching books, that in any but an extremely dry climate they are liable to rust and eat through the paper which they are supposed to fasten.

## OBITUARY NOTES.

GENERAL WILLIAM B. HAZEN, Chief Signal-Officer of the War Department, died in Washington, January 16th, in the fifty-seventh year of his age. His death was unexpected, although he had been in bad health for a long time. He was born in West Hartford, Vermont, in 1830, and entered the Academy at West Point in 1851. After graduation, in 1855, he served for five years in the Indian campaigns of the West. At the beginning of the civil war he was assistant instructor of infantry tactics at West Point. Entering active service as a captain in the regular army, he recruited the Forty-first Regiment of Ohio Volunteers and commanded it. He served through the war in the West under Buell, Rosecrans, Thomas, Grant, and Sherman; participated in the principal battles of their campaigns, and was officially recognized, by promotion or brevet, several times, for conspicuous services. He was appointed Chief Signal-Officer in 1880, and distinguished himself in that capacity by his effort to enlarge and extend the weather-service.

M. EDOUARD ERNEST BLAVIER, a distinguished French electrician, died on the 14th of January, in the sixty-second year of his age. He was inspector-general of the telegraphic lines, Director of the Superior School of Telegraphy, and Vice-President of the International Society of Electricians. He was the author of contributions to the learned societies, the "Telegraphic Annals," a "Course in Telegraphy," which is an authority on the subject, and a "Treatise on Electrical Magnitudes and their Measure in Absolute Unities."

MR. JOHN ARTHUR PHILLIPS, who died suddenly on the 4th of January, was a chemist of considerable distinction for his researches in connection with mineralogy and metallurgy.

MR. THOMAS MOORE, who was a prolific writer on botanical and horticultuaral subjects, and was for many years Curator of the Botanic Garden of the Society of Apothecaries at Chelsea, England, died on the 1st of January, in the sixty-seventh year of his age. He was best known for his numerous publications on ferns.

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## FRESH AIR AND BATHING AS RESTORATIVES.

We believe in the theory and the practice of resorting to fresh air, mountain retreats, quiet country homes, seaside rambles, etc., as restoratives to enfeebled constitutions, but there are many chronically afflicted who find only temporary relief, and need a different revitalizing agent. The following letter illustrates this point and shows the wisdom of the one most interested in the case.

One of the favorably known merchants of New York—one who has been planted and rooted for a long time in the same place—is Mr. J. H. Johnston, jeweler, of No. 150 Bowery, New York, where he has been established over thirty years.

His wife is a most estimable lady, and is known as a writer of marked ability. Those who see her now, in the enjoyment of excellent health, would hardly suppose that four years ago she was an invalid wavering between the love of life and a constant prospect of death. To one of our correspondents, who visited her, Mrs. Johnston said:

"When I went to Washington to attend the inauguration of President Garfield, I was exposed in stormy weather and caught a severe cold. It settled on my lungs, producing serious results, among which were an obstinate cough and sharp pains in my lungs. Mr. Johnston became alarmed, and took me to Florida the following winter. I was, by this time, unable to sit up for a moment, and was with great difficulty conveyed to the steamer, overhearing the remark from a bystander, as I was being transferred from the carriage to my berth, '*There goes another to be brought back in a box.*' The sunny days partially restored my health, but on the approach of winter again my cough increased and strength vanished. My appetite was entirely gone. I swallowed food in daily decreasing quantities and from a sense of duty only. Still, I fought the idea that I had entered on the decline that ends in death.

"I had heard of Compound Oxygen, and I determined to investigate it. My husband and I went to Philadelphia to learn its merits at headquarters, Dr. Starkey examined me, and told me what I already realized, namely, that my case was a serious one, and that unless the hæmorrhages were checked I would not live over three months. I was deeply impressed with his earnestness. I tried the Compound Oxygen at once and found a prompt benefit. This increased daily, and the cure eventually proved permanent. The weary, nervous depressions to which I had yielded gave way to sunshine and hope; the pain in my lungs gradually faded away, and the severe aches in my side no longer afflicted me; my sleep, before restless, became even and quiet; shortness of breath was succeeded by a facility for using the full breathing-power of my lungs; my capricious appetite became a natural one and I began once more to enjoy life. I always keep the Compound Oxygen in the house, and take it on [illegible] ovocation. It always acts benefi-

[illegible] re to Compound Oxygen alone, [illegible] nedicine, and the weather pre- [illegible] or exercise. I really believe [illegible] all lung-diseases, and you are [illegible] ame in recommending it."

## THE MYSTERY OF HUMAN MECHANISM.

How often do physicians find upon a second visit, that the medicines they had left, or the prescription they had ordered, had either failed to effect the desired change, or produced an unlooked-for result. It is surprising how many, when they send for a doctor, do so with the idea that if they tell him "I feel all out of sorts," "I think my liver is out of order," "I have a pain in my heart," "I feel as if I would suffocate," or, "I have a misery in my back," "Now, doctor, won't you give me some medicine to cure me and make me well again?" As well might the owner of a factory go to some machinist, or send for him to come to his counting-room, and there tell him, "Sir, there seems something wrong with the machinery," or, "The engines don't work right," or, "There seems something wrong with the boiler; won't you send up something that will make it all right again, or will you tell me what to send for and what to do, and then my mill can go right on?" What would be the machinist's reply? "Why, you fool, I can't tell you what to do till I see what is the matter. It may be a loose pulley in the machinery. It may be a broken bolt or broken key in the piston-rod. It may be the fault of the pump, or one of a thousand other things; and I must examine—I must see what is the matter before I can tell what should be necessary to be done." If the doctor could act the part of a machinist—could take out the heart as he would take off the force-pump, unscrew the cylinder, take out the piston, open and examine the valves, wipe out all the chambers, put in new screws, renew the packing, oil the journals, redress the valves, then when he put it together again, he could say with confidence as he would go away, "There, when you start that pump or heart again, it will work all right." Smart indeed, and justly famous, would be the jeweler who could take up a useless watch, look on its face, feel its dead stillness, or listen with it close to his ear the wondrous tick of its escapement, and without opening it, and without using his eyeglass to peer into its movements, say off-hand and at once: "Your watch has a worn pinion, or has dust among the cogs and in the ratchet-wheel. All that is wanted is a little cleaning out, and it will run all right."

How ready are we to grumble at our doctor if we do not get well, and become restored to health as rapidly as we desired! Is he not the true physician, then, who says: "I can not look into your body and discern clearly the exact condition of each affected organ. Such and such organs appear to be affected. I will endeavor to assist nature, by giving it an extra supply of the needed material elements to take the place of the diseased atoms and expel them." Such is the effect of true, pure, and simple revitalizing agents. They do not and will not aggravate the body, but their essential attribute is to render aid to all efforts of nature to eliminate discordant elements, and never to retard nature's work. Such is the Compound Oxygen Treatment.

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